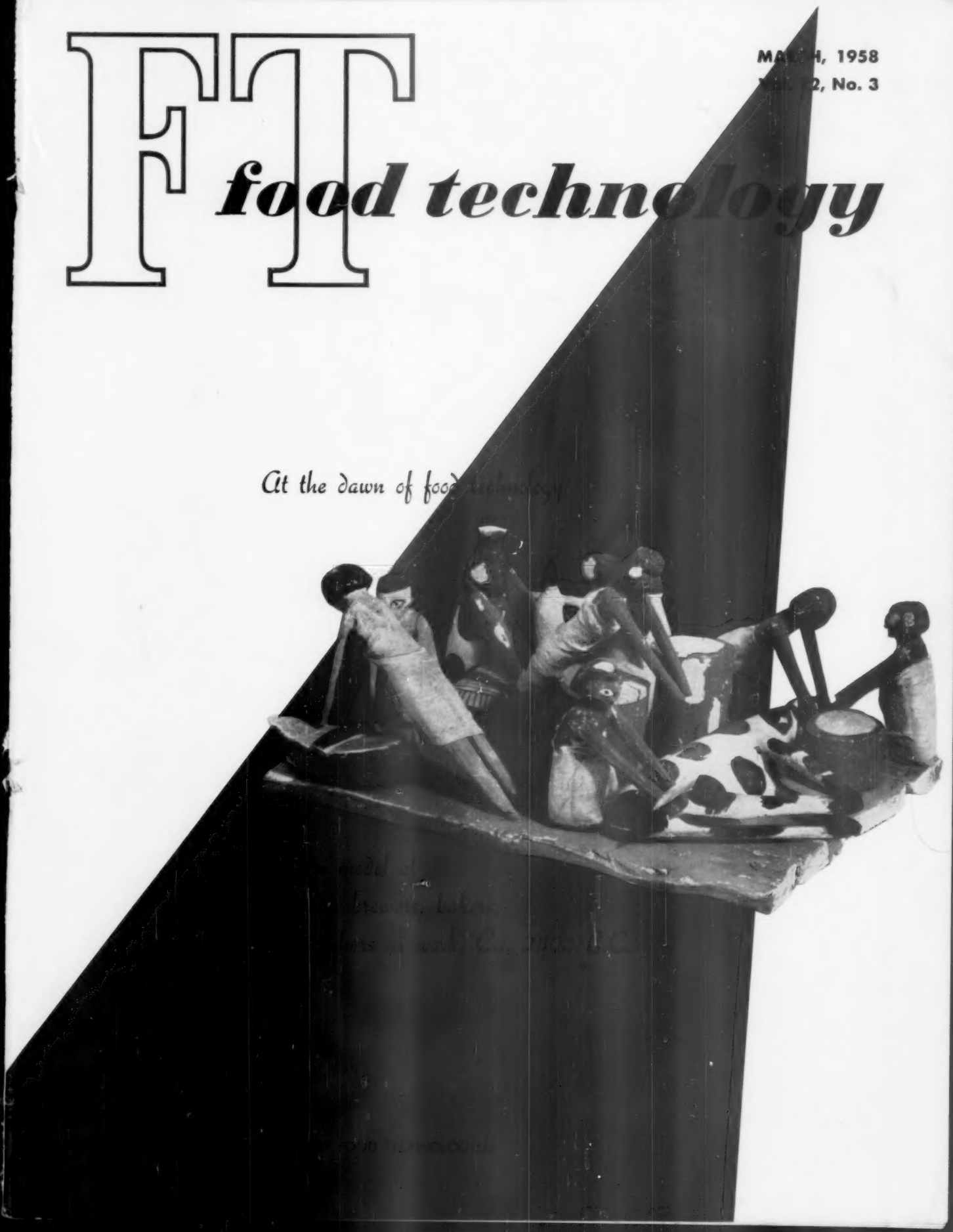
MARCH, 1958
Vol. 12, No. 3

FT food technology



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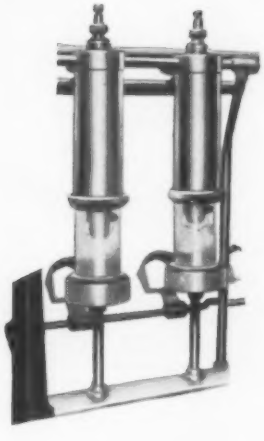

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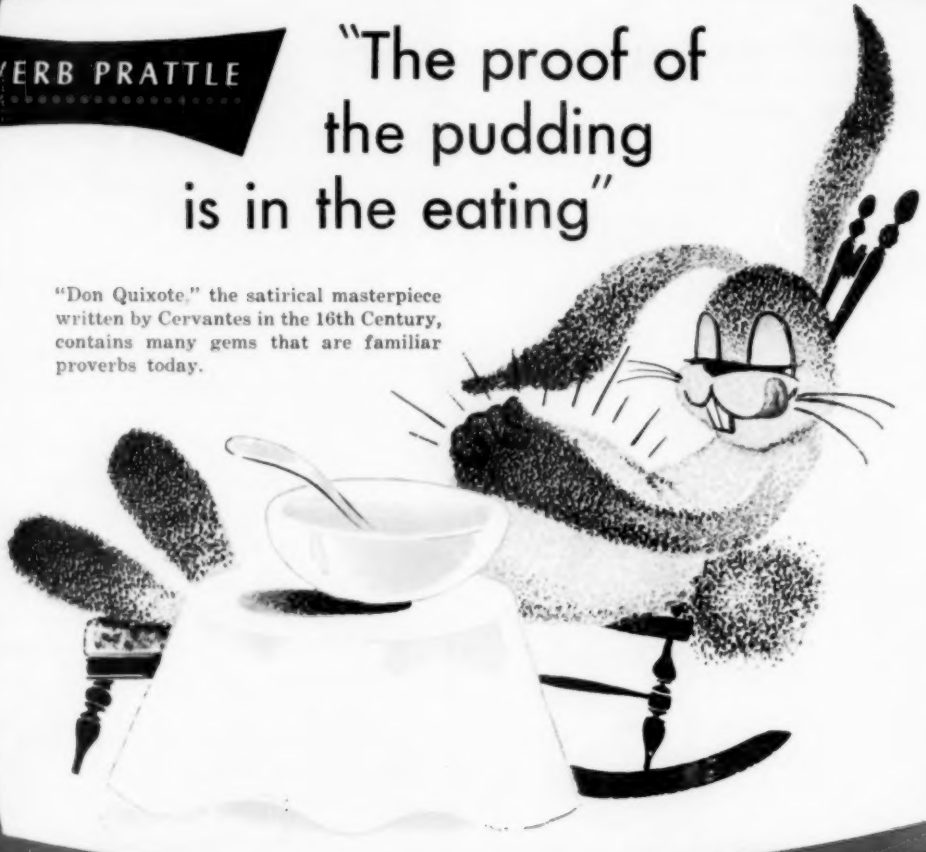

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FT food technology

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IN THIS ISSUE—

THE TECHNICAL ARTICLES IN BRIEF

Evaluation *Factors to consider in formulating microbiological standards for foods*

Microbiological standards for foods. II. What may microbiological standards mean? F. S. Thatcher.

Degree of public health hazard, significance of specific microbial counts, practicality, economics, validity of opinions as to harmfulness, problems of enforcement, scope of application—these and other considerations in setting up microbiological standards are evaluated and discussed by a scientist of the Canadian Food and Drug Directorate. (See page 117).

Testing *Sanitary conditions; shelf-life of dressed poultry*

Studies on microbiological mehtods for predicting shelf-life of dressed poultry. W. L. Mallmann, Lawrence Dawson, Barnet Sultzer and Herbert Wright.

A color test dependent upon the reduction of a nutrient medium was used. The medium was designed to allow rapid growth of psychrophilic bacteria but to suppress the growth of mesophilic bacteria. The medium was incubated at 20° C. for a maximum period of 48 hours. The test was designed for plant use so that the need of better handling and sanitation can be determined in 24 to 48 hours after processing of the poultry. (See page 122).

Statistics *Applied to formation of quality scales*

Statistical construction of objective quality scales. Mae-Goodwin Tarver and Anna May Schenck.

Formation of quality scales when physical characteristics are measurable is relatively simple. By use of the method of least squares, the regression line relating the physical measurement to a subjective quality scale may be drawn and variation of rating or scoring panels may be estimated. Some quantities or properties of a complex physical nature, such as taste, odor, wholeness, firmness, product breakdown, etc., are not easily measured and formation of quality scales then becomes more difficult. However, by the use of least squares, the relationship between a degrade rating and a subjective quality rating may be determined. The variation in the scoring or rating panel may also be estimated. Numerical weights may be attached to total acceptability either by multiple regression techniques, by the reciprocal of the variance, or by the slopes of the individual regression lines. It is also possible by using either the geometric or the harmonic mean in scoring systems to produce an automatic zero total score if any one of the faults in the total score is zero. The statistical construction of various objective quality scales is outlined in this paper and illustrated by representative data. (See page 127).

Antibiotics *Sockeye salmon*

The potential application of antibiotics in the salmon canning industry. II. Chemical and bacteriological evaluations. J. A. Stern, H. L. Liebman, G. Kudo, J. Chapel, R. A. Olsen, L. Farber and M. Grennan.

Under the conditions of this investigation, oxytetracycline and chlortetracycline retarded the spoilage of sockeye salmon. The overall storage life appeared to be extended by a factor of approximating 1.5 over the cases where no antibiotics were used. Extension of storage time was dependent on temperature. At the high storage temperatures (65 ± 5° F.), the absolute time of extension was relatively small, while at 32° F., the absolute time of extension was considerable. Chemical and organoleptic examinations substantiated the above conclusions. Results of the bacterial examination were inconclusive, probably due to the fact that the samples were stored at freezing temperatures prior to examination. Assays for residual antibiotic activity in the canned product were negative. (See page 132).

Waste control *Stream pollution*

The role of state sanitary commissions in waste control. F. B. Milligan.

Reasons for pollution control are given; namely, to protect water resources for industrial and agricultural use as well as for domestic supplies and recreation. Polluting effects of industrial and agricultural wastes are described, including: acids and toxic metal salts from metallurgical plants; taste- and odor-producing phenols from by-products coke plants, inert material from colleries, sand washeries, and above all, soil erosion including that from farms, which may blanket stream beds and smother aquatic life; radio-active wastes from nuclear reactors and from some users of radio-isotopes; oil and other objectionable material from petroleum refineries; decayable substances from food-processing establishments such as canneries, abattoirs, and milk plants, and from pulp and paper mills, tanneries, textile mills, and from almost all other water-using industries. Development of laws for the control of stream pollution is presented, with Pennsylvania used as an example. State commissions for control of wastes with respect to water pollution, their functions and operation, are discussed. The Pennsylvania

March Cover. The technologies of brewing, baking, sun-drying, and many others were practiced and advanced by the ancients. Shown on the March cover, courtesy of the Oriental Institute, University of Chicago, are Egyptian bakers, brewers, meat-cutters, and cooks busily providing food and drink for the journey into the other-world of a departed high official of ancient Egypt.

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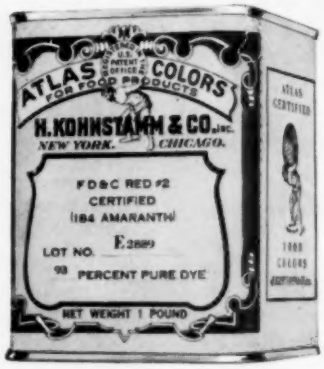

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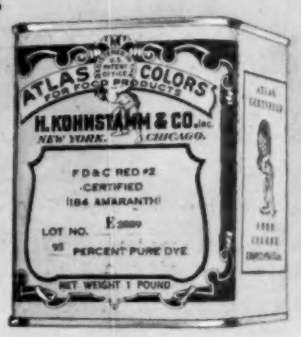

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Sanitary Water Board's policies and program, again as an illustration, are explained. Industry action committees have cooperated with the Pennsylvania Board from the outset. (See page 137).

Flavor improvement *Dill pickles*

The effect of sucrose and type of spicing on the quality of processed dill pickles. Rose Marie Pangborn, Reese H. Vaughn, and G. K. York, II.

A trained taste panel observed two main flavor defects in commercially processed dill pickles; high apparent acidity (acetic acid) and unbalanced spicing as indicated by harsh flavors. Consequently, processed dill pickles were packed with two spicings; genuine and spice oils, and at three sugar levels; 1.0, 1.5, and 2.0% sucrose by weight. The addition of 2.0% sugar improved the pickle flavor quality significantly over the controls by counteracting the apparent over-acidity and by enhancing the spicing flavors. High salt levels (4.21 and 5.03% NaCl) upset the balance between acid, sugar, salt, and spicing in two of the samples. More salt was found to be present in the brine than in the whole pickle. Pickles containing genuine spicing were considered superior in flavor to those containing spice oils. Color, texture, volatile and fixed acidity, and pH were unaffected by the addition of sucrose or by the type of spicing. (See page 144).

Antibiotics, chlorine *Fresh fryers*

Effect of certain bacterial inhibitors on shelf-life of fresh fryers. R. J. McVicker, L. E. Dawson, W. L. Mallmann, Sue Walters, and Evelyn Jones.

An evaluation of the effects on acceptable fryer shelf-life of chlorine and the antibiotics, chlortetracycline and oxytetracycline was made. Data from two replicate studies were analyzed and presented. Shelf-life was determined by a combination of bacterial counts, raw odor evaluations and cooked flavor. Fryers cooled in ice water containing 10 p.p.m. chlortetracycline had lower bacterial counts and a longer shelf-life, as evaluated by raw odors and cooked flavor, than did those cooled in ice water, ice water plus chlorine and ice water plus oxytetracycline. Cooked flavor differences were less noticeable. Odor and flavor scores of the chlortetracycline treated birds were lower than controls during the first 4 days after processing, but were higher during the final week of evaluation. Oxytetracycline and chlorine, in these two trials, were both less effective than chlortetracycline in extending shelf-life of fryers. (See page 147).

Chromatographic analysis
Sugars in sweet potatoes

The effects of curing, storage and dehydration on the mono- and disaccharides of the sweet potato. M. G. Lambou.

Chromatographic investigations are reported on the sugars in selected samples of raw sweet potatoes and their diced dehydrated counterparts—representing freshly harvested, cured, and 60° F. stored stock. Total sugars extracted from the raw roots contained a major percentage of sucrose ranging from 75% after curing to 66% at the end of 6 months of storage. With respect to the ranges for glucose (7-11%) and fructose (6-11%) the higher values were found in the stored stock. A small quantity of maltose (2.7-4.0%) was found, possibly an artifact. A trace of inositol observed in the freshly harvested sweet potatoes increased to a maximum after one month of storage and then decreased. In the dehydrated products made from the same raw stock, maltose made up 51 to 60% of the total sugars; sucrose 23 to 32% and glucose, fructose and inositol smaller proportions (2.6-5.8%, 2.2-4.5% and 0.78-6.6% respectively). The quantities varied with the condition of the raw material used. The findings, in general, confirmed those of earlier workers. (See page 150).

Radiation preservation *Fresh apple juice*

Effects of gamma irradiation on the chemical and microbial composition of fresh apple juice.[1] E. A. Asselbergs, W. E. Ferguson, and K. F. MacQueen.

Irradiation of apple juice at 621,000 r or lower does not produce sterile juice. After irradiation at 621,000 r in the presence of sodium sorbate (0.05%) and ascorbic acid (75 mg./100 ml.), the juices can be kept at room temperature for thirteen days without the development of micro-organisms. However, alterations in flavor, viscosity and color seriously reduce the quality and acceptability of the juice. (See page 156).

Packaging *Prepackaged meat*

Factors affecting quality of prepackaged meat. III. Chemical tests associated with organoleptic quality factors other than color. H. Broumond, C. Olin Ball, and Elizabeth F. Stier.

Free amino nitrogen, free acid of lean samples, peroxide value, free fatty acid and iodine value of fat samples were determined. A significant negative correlation between free fatty acid and flavor of fat samples was observed. Using the results of chemical analyses, performances of various films for packaging fresh meat were evaluated. (See page 159).

Browning *Dehydrated carrots*

Carotenoid stability in stored dehydrated carrots. G. Mackinney, A. Lukton, and Leona Greenbaum.

Data are presented which show that in the absence of molecular oxygen, the carotenoids of dehydrated carrots and β-carotene in a glucose-glycine synthetic mixture are unaffected by severe browning. (See page 164).

Measurement, color *Conversion procedures*

Procedures for conversion of color data from one system to another. Paul Esau.

Conversion of color values from Maerz and Paul to the Munsell system is simplified by means of a table, complete with instructions. Procedure for converting Munsell values to the C.I.E. system is also given. (See page 167).

Of Professional Interest

Food Additives—The Case for the Ad Hoc Scientific Advisory Committee

As Related to Pending Federal Legislation

In view of the expected resumption of Congressional Hearings and debate on legislative proposals on food additives, the IFT's Committee on Food Additives, which met in Washington December 13, 1957, felt it would be of interest to present to the IFT membership some of the individual views on specific features of the Bills now pending in the present 85th Congress.

Dr. B. L. Oser, Director, Food and Drug Research Laboratories, New York City, and a member of IFT's Committee on Food Additives, has stated the case favoring the Ad Hoc Scientific Advisory Committee, in a communication as it appears below. This letter was sent to the former Chairman of the House Interstate and Foreign Committee, the late Honorable J. Percy Priest. It is published on pages 242-244 of the Official Record of Hearings on Chemical Additives in Food as published for the use of the Congressional Committee named above.

Food Research Laboratories, Inc.
Long Island City, N. Y.

Representative J. P. Priest, *Chairman,*
Chairman, Subcommittee on Health and Science, House Committee on Interstate and Foreign Commerce, House Office Building, Washington, D. C.

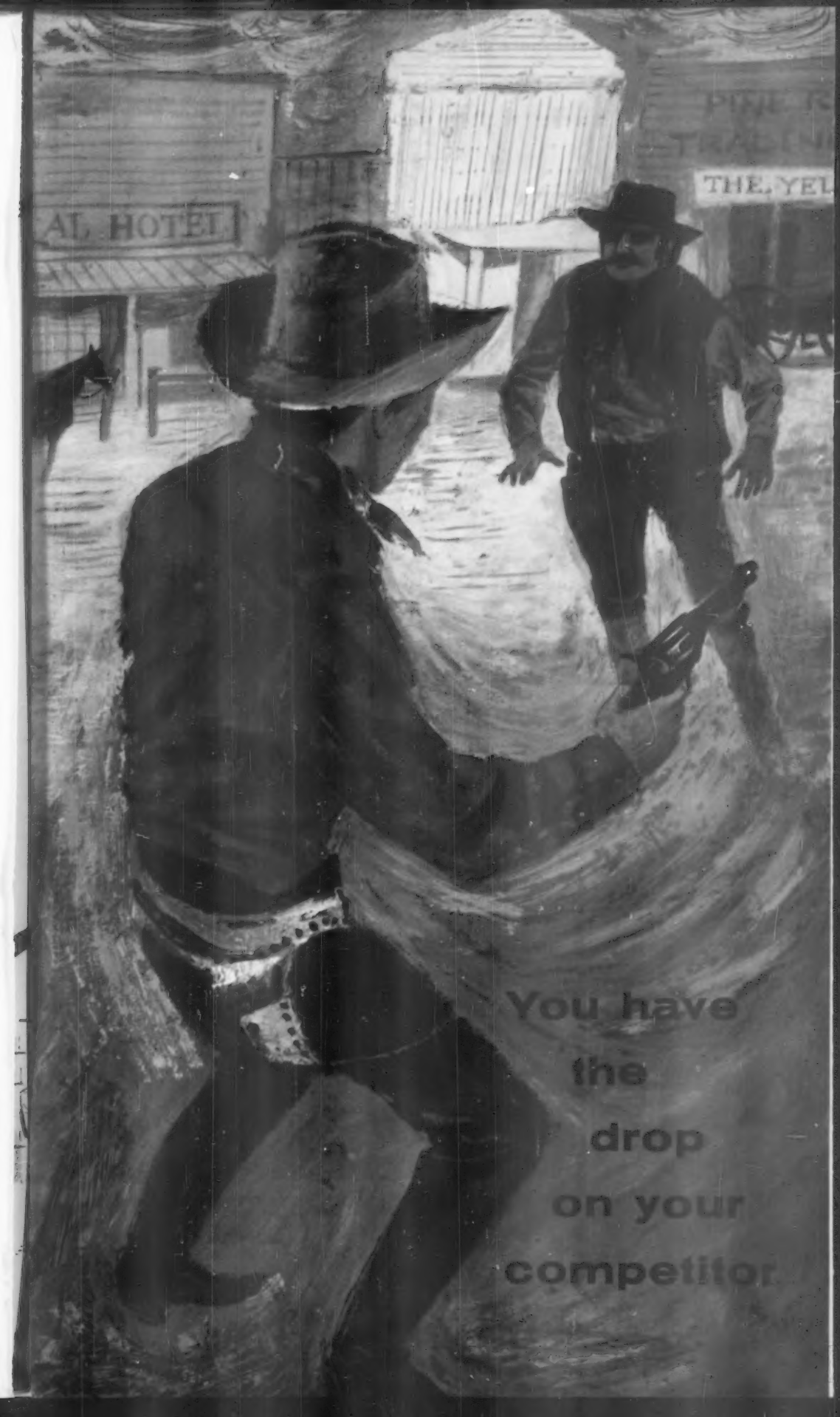
Dear Sir: By way of identification I may say that for the past 30 years I have been connected with the Food Research Laboratories, Inc., an independent consulting and research organization, since 1934 as director. My training and experience has crossed the lines of food technology, nutrition, and toxicology, and so I have inevitably been drawn close to many of the problems associated with food additives now before your subcommittee. I have written and spoken much on the subject before both scientific and legal audiences as the enclosed reprints will attest. I am also a member of several association committees including the National Research Council's subcommittee on food technology of the food protection committee. However the present comments are offered in my individual capacity, not as a representative of any clients, associations, or committees on which I hold membership.

It was my privilege to listen to the hearings you so ably conducted on January 31 to February 3 and on February 14. I was struck by the fact that while much was made of the complexity of the scientific issues involved, no representatives of the National Research Council, the American Public Health Association, nor indeed of any scientific organizations (aside from the Food and Drug Administration) presented testimony. This may have been unnecessary but it seemed to me, perhaps in retrospect, that at least one of the controversial subjects might have benefited from a scientist's viewpoint, viz., the question of procedure for review of an adverse administrative ruling on safety.

This may be a case of a scientist stepping in where lawyers fear to tread but for whatever it may be worth to your committee in its deliberations I should like to offer the following comments which, if you wish, may be entered into the record.

Tremendous gains have been effected in the widespread acceptance by industry of the principle of mandatory pretesting and in the Food and Drug Administration's apparent acquiescence to liberalizing the law by virtual abandonment of the per se doctrine, both of which provisions are contained in the Priest-O'Hara bill (H. R. 8271 and 8275). Adoption of even a modified "grandfather clause" is likewise a great forward step. However the crucial question which, according to observers, bids fair to hold up this new legislation, is the matter of court review of administrative decisions as to the adequacy of safety evaluations.

There seems to be agreement on all sides that this is a complex scientific question which some argue that scientists alone can "settle," others that the issues can be decided by lay courts before which experts would establish their qualifications and be subjected to cross examination as in patent cases. Cogent argu-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ments were advanced by Judge Biggs for the judiciary and Mr. Goodrich for the Food and Drug Administration against de novo trial of these scientific questions. Nevertheless an appellate procedure which makes the Secretary's unilateral findings of fact (if supported by substantial evidence) binding upon the court of appeals, would seem to vest too much judicial authority in the Administrator's office.

Hence I would like to present the case for interposing the option of scientific review of an Administrator's adverse decision before proceeding with judicial review, in other words, to advocate fuller consideration of the provision for the ad hoc advisory committee contained in Dr. Miller's bill (H. R. 8748) or, preferably as described in the recently enacted section 408 of the Food, Drug, and Cosmetic Act.

(I should mention that I was among those who urged this new departure in administrative procedure long before its adoption and have also had personal experience with its operation in the only case where it has thus far been invoked.)

Arguments for the Ad Hoc Advisory Committee of Scientific Experts

1. The ad hoc committee procedure makes available the opinion of the Nation's top-flight experts on any particular scientific question, no matter how specialized it may be. Their impartiality is assured by the manner of their selection (i.e. from a panel chosen by the National Academy of Science) and by the public responsibility they assume. Objectivity is further assured by the fact that their views are exposed to the judgment of their scientific peers. Sitting as a kind of scientific supreme court, committee members as a group abandon prejudices or partisan attitudes if perchance such might have existed.

2. The FDA, we are given to understand, even now consults such experts in arriving at its opinion on difficult or controversial questions. However, these experts usually are anonymous, the approach is entirely one sided, and their views do not become a matter of record.

3. The advisory committee does not supersede the authority of the Administrator nor does it relieve him of his ultimate responsibility. It merely provides the petitioner with the opportunity to lay his case before an independent jury of scientific experts whose report and recommendations become part of the record for use in the event of appeal to the court.

4. Unlike judicial bodies, however, advisory committees, having been selected on the basis of their thorough knowledge and understanding of the scientific or technological issues involved, are able readily to sift the wheat from the chaff in the evidence advanced for safety and hence expedite cases which might take many months to resolve in the courts. I respectfully submit that a group of scientists is better able to understand and assess technical data and to judge the credibility of scientific witnesses than are juries of laymen or even judges, however distinguished they may be in their juristic capacity.

5. Some of the questions the Food and Drug Administration is being called upon to decide are extremely difficult and involve judgments which may in the future have to be reversed. It is inevitable that under such circumstances extreme conservatism has to be observed. But if the Administrator in arriving at his decisions is able to take into account the publicly expressed view of a body of eminent experts, he would have greater moral support for such "calculated risks" as his decisions might entail. He would be less subject to embarrassment in the eyes of the public in the event of a future reversal of policy, as in the cases of agenized flour, coumarin, and certified food colors.

6. It has been said that the scientific questions are not too technical for the courts to handle. With this I would take issue. The problems are not, as one witness suggested, concerned with label representations or "honesty and fair dealing" where consumer reactions are involved. They deal rather with physiological responses of experimental animals, translation of effects from one species to another, intermediary metabolism, interpretation of biochemical analyses or pathological slides, and the like. They are difficult even for specialists to resolve. In lawsuits

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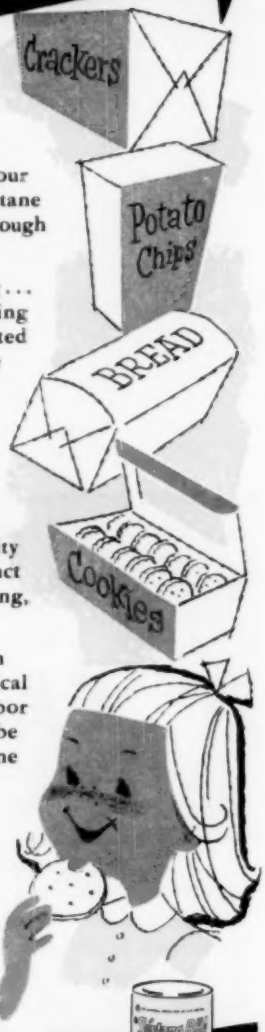

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it is the opinion of the expert, his interpretation of the facts that the court accept or reject, rather than the observations upon which they are based. Is this not the very reason that the judiciary is bound by an Administrator's "findings as to the facts"?

7. Whereas the Administrator would neither evade nor avoid his ultimate responsibility, cumulative experience with ad hoc advisory committees would provide him with invaluable guidance in the discharge of his obligation of making safety evaluations. The stature of the membership of such committees would help make decisions more palatable to the regulated industries.

8. Recourse to ad hoc advisory committees would in practice almost eliminate the need for court review for the following reasons:

(*a*) In the first instance most manufacturers acquiesce in the opinions of the Food and Drug Administration for reasons of policy and expedience.

(*b*) Referral to an advisory committee would entail considerable expenditure of cost and effort with little *a priori* expectation of having the Administrator reverse himself.

(*c*) If the committee were to sustain the Administrator, the petitioner would be unlikely to gain much by going to court.

(*d*) If the committee took an opposite view from the Administrator, the latter could reverse himself in which case there would be no occasion for appeal to the court.

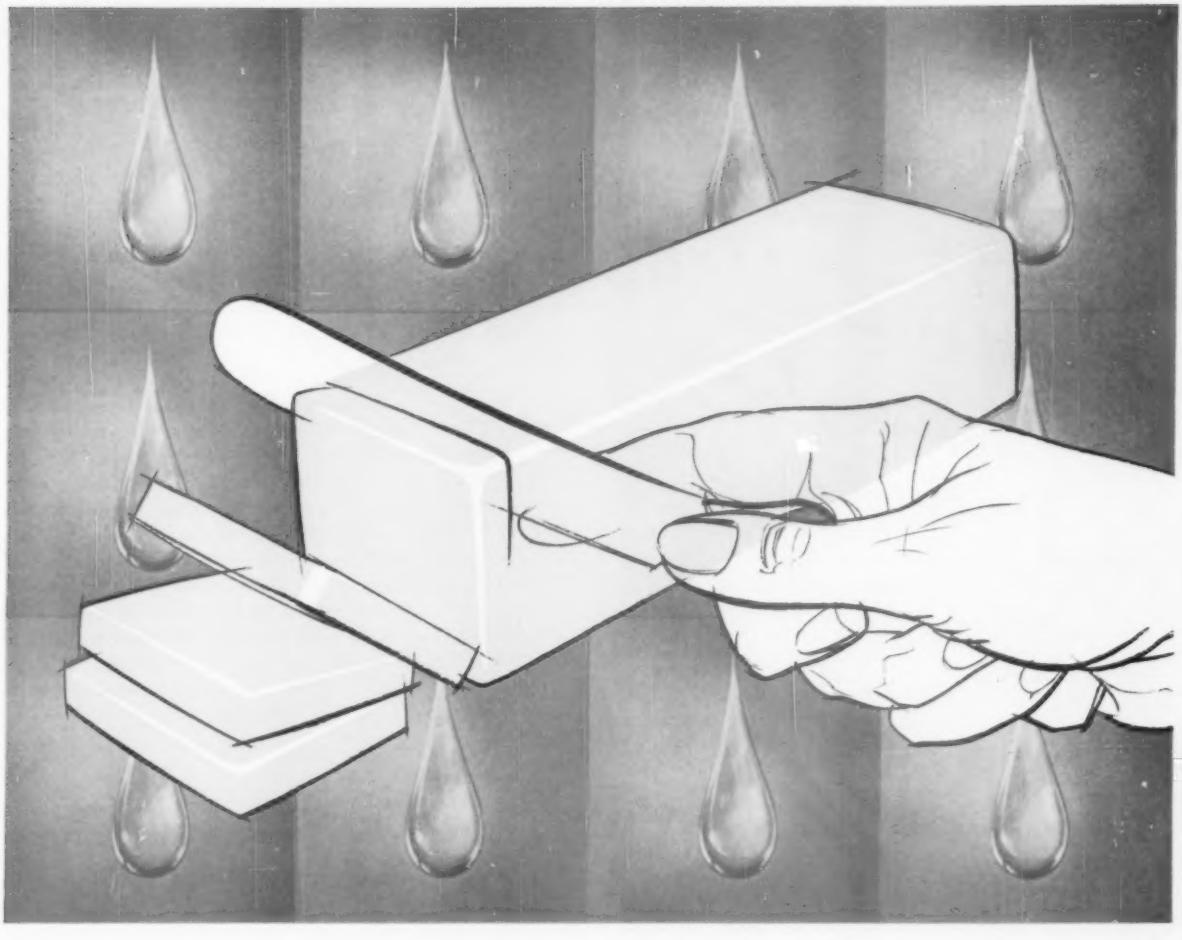
(*e*) Only if the Administrator held steadfast to his original opinion, despite the committee's recommendation to the contrary, would a petitioner have to consider the advisability of further appeal.

9. It has been argued privately that the Secretary could "stack" an advisory committee by selecting from the panel offered by the National Academy of Science experts believed to favor the views of the Food and Drug Administration. Its regard for the opinion of the scientific world, which the Food and Drug Administration respects and esteems, as well as for public opinion would militate against such practice. In fact I personally believe it is more reasonable to expect that the Food and Drug Administration would lean in the opposite direction.

10. Finally it may be pertinent to suggest that some of our outstanding scientists are repelled by the inquisitional atmosphere of a courtroom and find it an objectional arena in which to wage scientific battles. I feel sure that more and better scientists would be willing to offer themselves as experts if their deliberations were conducted on a more scientific plane around the table. It would be in the public interest to make available the greatest possible number of our best qualified specialists to help resolve these thorny scientific questions.

Respectfully submitted.

BERNARD L. OSER, Ph.D.,
Director, Food Research Laboratories, Inc.



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IFT News

The 1958 "Careers in Food Technology Day"

Bill Klinker
Purdue University
Lafayette, Indiana

THE 1958 "CAREERS IN FOOD TECHNOLOGY DAY" of the Indiana Section of the Institute of Food Technologists is history. A noteworthy achievement was a doubling in the number of schools represented. Students, counsellors and members from as far north as Lafayette, Eaton, and Portland which are about 60 miles north of Indianapolis and as far south as Jeffersonville, which is on the Ohio river, journeyed to Indianapolis to hear representatives of education and industry describe the interesting and challenging profession of food technology. Indianapolis, the host city, and nearby communities were well represented at the meeting.

State chairman, Seb Davin, gave a short welcoming address.

A BRIGHT FUTURE FOR FOOD TECHNOLOGISTS

Dr. Gale Ammerman led off the parade of noted guest speakers. Although he did not neglect the economic advantages of receiving a college education, the far more important fact that an interesting, challenging, and rewarding employment were desirable goals of the individual was emphasized. It was pointed out that the goal of education is to produce a whole, well developed man who will be more than a tool of society, but a vital contributor to it.

Dr. Ammerman reviewed the size of the industry and the variety of positions open to those interested in the profession. He presented facts to show that our population and our need for food is growing. He indicated that an education for a career in the food industry is not an easy way to a Bachelor's Degree. He believes that the future is bright in food technology for the student who is willing to dig in and get a good background in the sciences which are the fundamentals of the profession.

Mr. Ray Wakefield, Director of Research and Quality Control, Gerber Products Company, illustrated how science is applicable to food processing by reviewing his years with the Gerber Company.

In the more than twenty-five years that Mr. Wakefield has worked for Gerber's the growth of the company has been rapid and with each new endeavor a new challenge. He pointed out that his first job with the company was to sell them on the value of his services. The development of more and more new products demanded a broad knowledge of the sciences and engineering.

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He pointed out the three criteria he believed important to be a success in the food industry. They are: a sound and thorough grounding in mathematics and the basic sciences in college; the ability to work with and through people; and hard work. The most important compensation to Mr. Wakefield for meeting these criteria has been a life that has never suffered from boredom.

What has happened to people you hired in recent years who were actual food technology graduates? This question was answered by three or four illustrations of how hard working food technologists may make remarkable advancements in the Gerber Company.

In closing, Mr. Wakefield emphasized the continuing world need for food and food technologists. He gave special emphasis to Dr. Ammerman's and his own statements that mathematics, chemistry, physics, biology, and engineering are the fundamental building blocks of a good food technologist. He wished all the students success and expressed the hope that their careers would be in food technology.

Lunch was served to students, high school and college counsellors, and members after the morning session.

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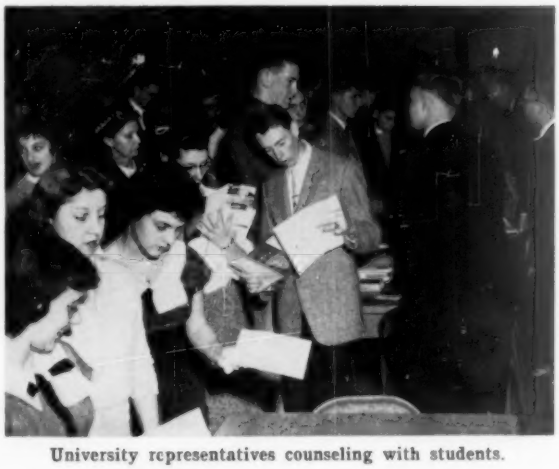

University representatives counseling with students.

AFTERNOON SPEAKERS STRESS INTEREST AS KEY TO CAREER SUCCESS

Immediately after the noon meal, time was given to the college counsellors from Illinois, Purdue, and Michigan State Universities to talk with students about the curricula which they offered in food technology. The fact that interest in these sessions was keen is significant. The Indiana Section considers this part of the program to be most important, since it is at these sessions that the students contact the men who will train them for their future in the food industry.

Dr. Martin S. Peterson, editor of FOOD TECHNOLOGY and technical editor Quartermaster Food and Container Institute, kicked off the afternoon session with a review of how food was processed in the old days. The large amount of time spent in production and processing was compared to the small amount spent today, and the even shorter amount of time that must be spent in the future if we are to meet the challenge of our ever growing population.

Rockets, airplanes, ships and the like are not all that is needed to keep up our national defense. Food is a must, and trained food technologists are needed to help keep our nation strong.

Interest is the quality that makes us eager to begin our day's work and carry it to its successful conclusion. Dr. Peterson told the students of many interesting and challenging problems in food. His theme was that we know a lot about food but we need to know more. In 1980, when many of the students present at the meeting will be in industry, the problems of providing more and better food for all will be theirs—and also, perhaps, providing food for space voyages.

Miss Betty Rosenberry, of the Broad Ripple High School of Indianapolis faculty, was the final speaker of the afternoon. She asked the students to think of their future.

"What will you be doing in five years?" was the question asked of them. The students should seek advice from their parents, teachers, and counsellors in making this important choice of careers.

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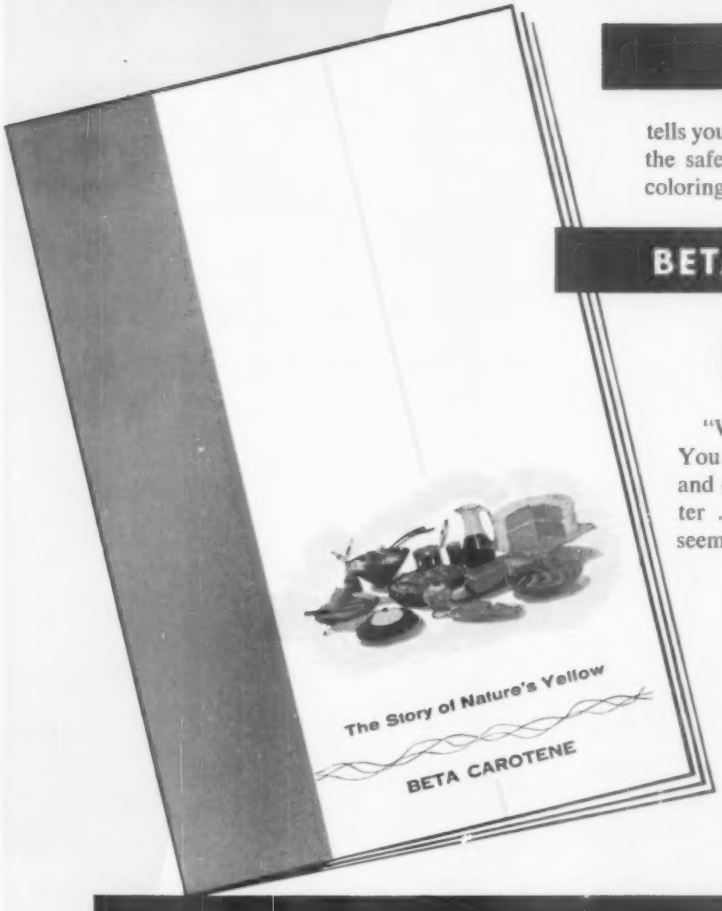

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Miss Rosenberry reiterated the importance of science in the food industry. She also indicated that lawyers, technical writers, transportation experts and the like are important in the large and complicated jobs of food production, processing, and marketing.

As a final thought for the students, Miss Rosenberry had this to say, "To be happy, which is a true measure of success, a person has to be working at something he likes to do. This may not always be the job which pays the most money or has the most glamour." This final thought seemed to be the predominant philosophy of all of the speakers on the program.

Selected movies of food processing operations, and an essay contest with two $50 awards were used to add variety and to stimulate the student to think of the future in food technology.

IT TAKES PLANNING

We would be remiss in discussing the actual events of the program without telling of the many hours of planning that went into it.

Committees were assigned seven months in advance of the actual career day. It was necessary to obtain a letter from the Indiana Secondary School Association as a credential for members to present at the schools they visited.

The "1958 Careers in Food Technology Day" Committee: George Clark—Stokely-Van Camp, Craig Ekermeyer—Standard Brands, Dr. Gale Ammerman—Purdue University, Dr. Lee Truman—State Chairman-elect, I.F.T., Pest Control Service, Seb Davin—State Chairman, I.F.T., Wm. J. Stange Co., Leslie Rutledge—State Councillor, I.F.T., Stokley-Van Camp, Al Rumminger—Bessire & Co., Bill Klinker—Purdue University.

A portfolio of magazine and newspaper items about the first "Career Day" and information about the second was given to all members who indicated that they would be interested in working on the program.

Contact with high school counsellors, teachers, science classes, and science clubs began about two months before the career day. Here the member must do a good selling job as cooperative high school counsellors and teachers are essential to the program's success. These people are constantly being approached by representatives of various industries and it is not an easy job to convince them that the program is worthwhile. The reward for this work comes when one sees the interest the students show at the counseling tables and the requests for copies of the speeches given.

This year over half of the students present requested copies of the speeches.

Our national officers are very interested in the program. They have appointed Mr. Al Rumminger, Bessire & Company, 101 East South Street, Indianapolis, Indiana as national chairman of a committee for "Careers in Food Technology Day" programs. Dr. Gale Ammerman, Mr. Craig Ekermeyer, and Mr. Hamilton Putnam are other members of this committee. Any section interested in conducting such a program may get detailed information from the committee members.

Chicago Meeting of IFT to Feature Many Valuable Field Trips

One of the newest and most modern research and development laboratories in the Chicago area is the Continental Can Company's Metal Division Research & Development Center on the south side. For many IFT'ers this will be a port of call on May 29, 1958, last day of the 1958 meeting.

Continental's new Center, the largest of its kind in the industry, covers more than 260,000 square feet of floor space. Its facilities include completely equipped chemical, physical, bacteriological and packaging engineering laboratories which specialize in all phases of research. Here, too, are laboratories for container design, development, and evaluation; metal plate, protective coatings, and can-sealing materials laboratories; experimental can-making lines for experimental trials of new materials, structures, tooling, can manufacturing methods and equipment; machine design drafting rooms, experimental machine shops and assembly areas for development and production of prototypes of new equipment; an ultra-modern test kitchen and flavor evaluation room; controlled temperature storage rooms ranging from minus 10° F. to 130° F; a modern 7,000 volume technical library; and a packaging engineernig pilot area for test packing foods, beverages, and industrial products under simulated commercial conditions. These are just a few of the areas highlighting the tours of these facilities. Small groups will be guided on 1½ to 2-hour tours by scientific personnel, following a complimentary luncheon in the Center's cafeteria.

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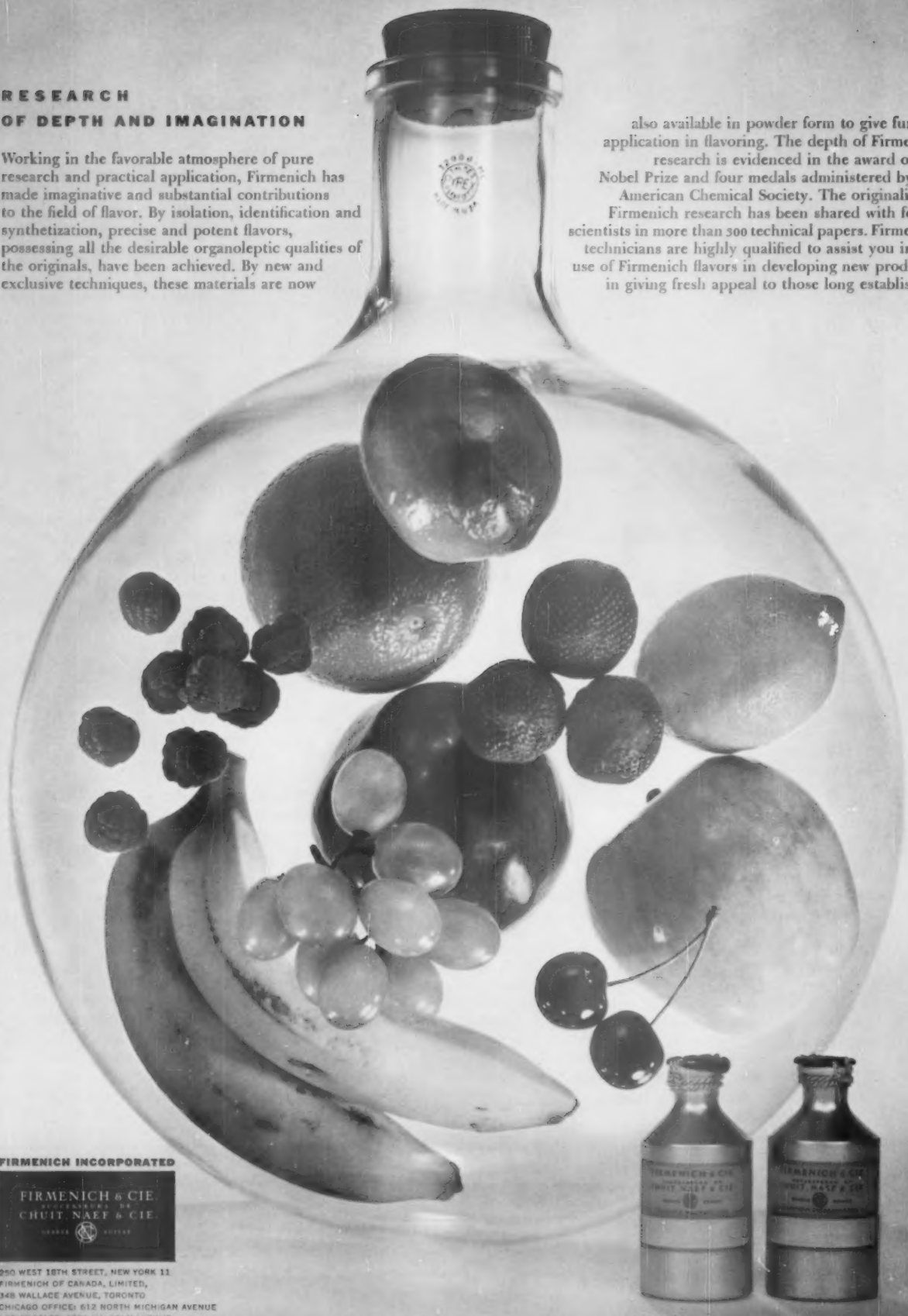

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St. Louis and Kansas City Sections Co-Sponsor University of Missouri Symposium

National officers of the Institute of Food Technologists, together with industrial and academic authorities in the field highlight the two-day Symposium on "Consumer Acceptance of Foods; Problems—Methods—Experiences", at the University of Missouri Memorial Student Union Building, Columbia, Missouri, March 14 and 15, 1958.

This is the Sixth Annual Food Technology Short Course sponsored by the University of Missouri, College of Agriculture in cooperation with the Institute of Food Technologists regular Sections of St. Louis and Kansas City. The Daniel Boone Hotel will be headquarters for the Food Technologists. A number of rooms will be available for attendants at the Symposium, both at the Daniel Boone and at the Tiger Hotel just a block away. For further information contact Dr. O. J. Kahlenberg, No. 4 New Agriculture Building, University of Missouri, Columbia, Mo.

Consumer acceptance problems, consumer acceptance methods, and experiences in meeting consumer acceptance requirements will occupy the attention of the participants. Dr. George Garnatz, Mr. Ray Wakefield, Col. C. S. Lawrence, and Dr. Emil M. Mrak, National president of IFT and banquet speaker, are among the featured speakers.

MINNESOTA

On Monday night, January 20th the Section held its annual Ladies Night. Wives and friends of members were guests for the evening. During the brief business meeting which followed the dinner, the newly elected officers for the 1958 season were announced:

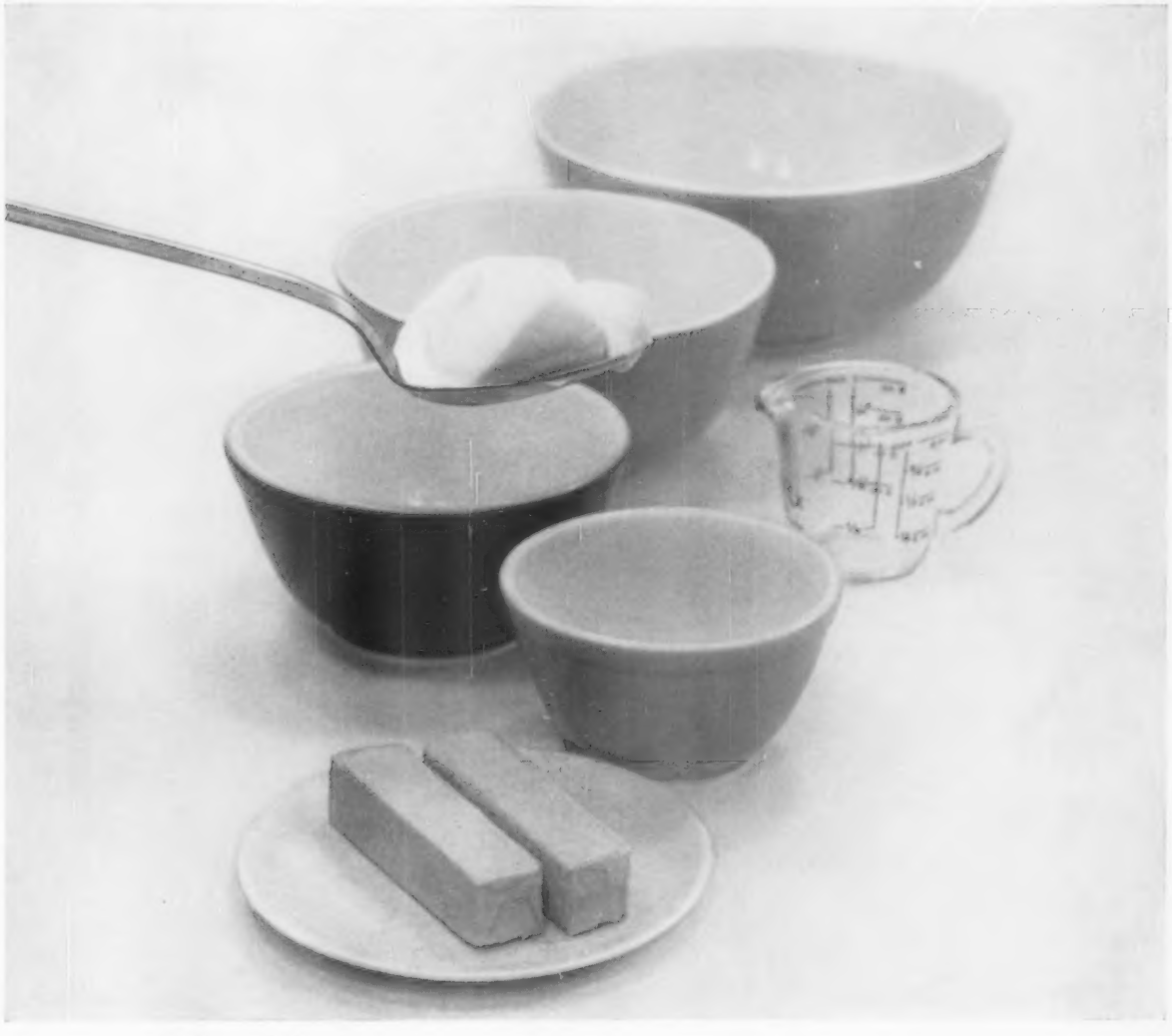
Chairman-elect—Dr. G. A. Vacha, Chief, Bacteriology and Canning Division, Minnesota Dept. of Agriculture.

Secretary-Treasurer—Norman Foster, Chief Chemist, Minnesota District, U. S. Food and Drug Administration.

Committee member-at-large—James Winter, Dept. of Horticulture, University of Minnesota.

Guest speaker Mary Hart, Home Economist, Minneapolis Tribune, gave her version of "The Life of a Wife" in terms of her work as a columnist, wife and mother. She described her weekly feature article "Around the Block", in which she reports on visits with homemakers. Miss Hart said," Most homemakers do not realize how talented they are. I'm 'just a homemaker' they all say. Instead, they have to be a jack-of-all-trades—interior decorator, chef, seamstress, dietician, accountant and child (sometimes even husband) psychologist." She compared her own position to that of a homemaker.

Miss Hart paid tribute to many of the Food Technologists who had helped her with scientific stories,



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The lady on the end of the spoon? Hardly. She never heard of them. Her interest in the shortening she uses extends only to how well it helps her bake nice, light cakes with good texture—and she hasn't the slightest interest in the *Myverol Distilled Monoglycerides* that help bring it about. Same with the margarine. She likes its creamy texture, how it tastes, how well it acts for frying.

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The purchasing agent? He likes *Myverol* because he finds his company spending less for this type of emulsifier. It is such concentrated mono that a little goes a very long way—much more than makes up for the slightly higher cost per pound.

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such as a 7-day series she wrote for women on the irradiation of food.

"Translating scientific language into simple terms for the layman is one of a reporter's jobs," she told the group. "But too often the scientist cannot interpret for the reporter."

Correction: Dr. E. Guenther will be the guest speaker at the May 22nd meeting instead of May 18th, as previously listed.

—Franklin L. Sorsensen Jr.

AK-SAR-BEN

At the January meeting, Dr. Alex S. Malaspina of the Chas. Pfizer & Company, Inc., Brooklyn, New York, spoke to the group on a subject of current interest: "Food Preparation With Antibiotics." Recent studies have indicated that certain antibiotics can be used to limit the growth of spoilage microorganisms in some types of food products. Dr. Malaspina talked about the application of these antibiotics to meat, poultry, fruit and vegetables. He also discussed the public health aspects.

Ben Sulskis

PHILADELPHIA

"Is freeze drying of foods a practical method of food preservation?"

Dr. Flosdorf, who for many years studied and aided in development of this process, discussed in detail this new and most interesting method of food preservation at the February meeting. In his early years of research, Dr. Flosdorf developed a practical process and equipment for the preservation of parenteral biologicals by the freeze drying method. He actually prepared the first blood plasma and serum in a freeze-dried form to be injected in man. It's interesting to note that this laid the foundation for the huge and successful Red Cross blood program at the onset of World War II. From this experience Dr. Flosdorf pioneered the application of freeze-drying to a variety of food products. Its application in meat products is of special importance and at present, many countries including the United States are now actively engaged in developing this method for both commercial and military purposes.

CHICAGO

Dr. R. L. Hall, Director of Research and Development, McCormick & Co., Inc., Baltimore, Maryland, was the speaker for January. His excellent talk "Some Aspects of the Cultivation of Spices" was followed by a film showing vanilla production through its growing, harvesting, and processing (curing) stages.

Section officers for 1958 are C. F. Evers, chairman; G. W. Beach, vice chairman; H. P. Furgal, secretary; L. E. Klinger, treasurer. Executive committee members are D. M. Doty and C. G. Ferrari. Councilors are J. M. Jackson and E. W. Nordlinger.

S. CALIFORNIA

SCRIFTS launched their program for the current year with a flourish and an enthusiasm which set up an anticipation of interesting times ahead. The gavel, wielded last year by Dr. E. B. Oberg (Carnation Co.), was ceremoniously put into the capable hands of C. G. Beisel (Exchange Orange Products) who immediately set the wheels in motion for maintaining an agreeable tempo of program movement. The retiring working-staff was introduced after which the chairman presented his current group: Henry Espoy (Barnett Lab.), chairman-elect; Gordon Miller (C & H Sugar), secretary; and S. I. Dulkin (Chem-Tech Lab.), treasurer, constitute office-holders.

Tribute was then paid to 15 past chairmen of the section by Marsden Burns, charter member. Leather pocket secretaries, individualized by names, were presented to attending members of this group.

Dr. Ernest Geiger, professor of Biochemistry at USC and director of research for Van Camp, speaker of the evening, gave an excellent summation and interpretation of present literature on the relationship of cholesterol and fat to atherosclerosis. A film distributed by the American Heart Association served to orient the audience and permitted more comprehensive presentation of experimental data. Of particular interest to the food technologist was the conclusion that although the level of blood cholesterol can be influenced by dietary factors, the extent to which blood cholesterol level influences atherosclerosis and heart disease has not been established. Dr. Geiger urged the continuation of research on the subject and suggested that food industries either initiate research projects or support programs already established in competent laboratories.

CALENDAR FOR 1958

Feb. 19th—Dr. Bernard Oser, "National & International Status of Food Additives"

Mar. 19th—Dr. Lloyd A. Hall, Griffith Laboratories of Chicago, "Technical Progress and Public Relations"

April 2nd—Dr. Axel Olsen, "Research Planning"

May 21—F. Leslie Hart, "Experiences in Brazil"

June, July, Aug.—Summer recess

September 17—Food Man of the Year

Oct. 17—All day meeting—Beverly Hilton Hotel, "Food Engineering"

November—Joint meeting with Cereal Chemists

December 3—Ladies Night.

—Cora Miller

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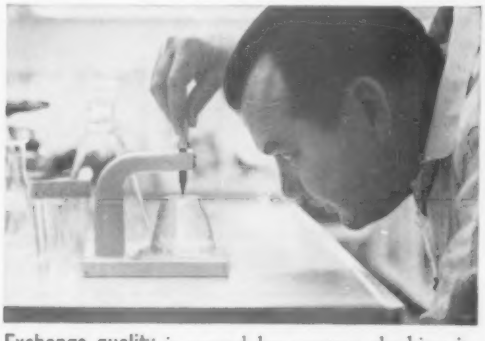

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FUTURE MEETINGS FOR FOOD TECHNOLOGISTS

March 14–15	Annual Food Technology Symposium and Short Course, University of Missouri, Columbia, co-sponsored by the St. Louis and the Kansas City Sections of IFT
April 7–11	The American Association of Cereal Chemists, Netherland-Hilton Hotel, Cincinnati, Ohio
April 21–23	American Oils Chemists' Society 49th Annual Meeting, Peabody Hotel, Memphis, Tennessee
April 22–24	Research and Development Associates of the Food and Container Institute, Palmer House, Chicago
April 24–25	Fourth Annual Nutrition Conference, Wayne State University, Detroit, Michigan
May 25–29	**Eighteenth Annual Meeting of the Institute of Food Technologists, Palmer House, Chicago, Illinois**
June 8–12	Inter American Food Congress, Americana Hotel, Bal Harbor, Miami Beach, Florida. For information address J. Arthur Lewis, Box 954, South Miami 43, Florida
June 10–13	First International Congress on Vacuum Techniques, Namur, Belgium

1959	
May 17–21	**Nineteenth Annual Meeting of the Institute of Food Technologists, Bellevue-Stratford Hotel, Philadelphia, Pennsylvania**
1960	
May 15–19	**Twentieth Annual Meeting of the Institute of Food Technologists, Civic Auditorium and Hotel Whitcomb, San Francisco, California**
1961	
May 7–11	**Twenty-first Annual Meeting of the Institute of Food Technologists, Hotel Statler, New York, New York**
1962	
June 17–20	**Twenty-second Annual Meeting of the Institute of Food Technologists, Americana Hotel, Bal Harbor, Miami Beach, Florida**

July 6–10	National Confectioners' Association 75th Annual Convention and Exposition, Sheraton-Palace Hotel, San Francisco, California
June 12–13	First National Convention, Canadian Institute of Food Technology, Queen Elizabeth Hotel, Montreal. Theme: Canada's Food Industries
June 9–August 29	Gordon Research Conferences, Colby Junior College, New London, New Hampshire; New Hampton School, New Hampton; New Hampshire and Kimball Union Academy, Meriden, New Hampshire.

An open invitation is extended to readers of FOOD TECHNOLOGY to send in to the Editorial Office, 11606 South Bell Avenue, Chicago 43, Illinois notices of annual or national meetings of interest to food technologists.

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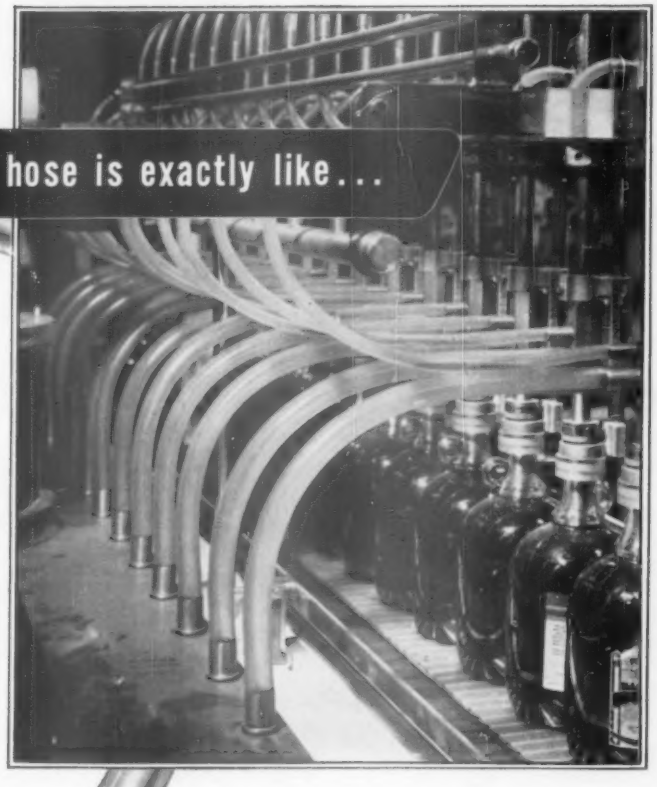

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Literature

INDUSTRY PUBLICATIONS

A technical bulletin offering details and step-by-step photos presents the story of the new Macbeth-Anseo **Densitometer** Model 12-A. The bulletin points up the features, including the 0-4.0 meter scale; its accuracy over the entire scale plus or minus .02 density units; instantaneous response; new optical system; and new narrow pass band filters. The bulletin can be obtained by writing Dept. P.10, Macbeth Corp., Newburgh, N. Y.

A 12-page bulletin, No. 2000, describing the "Select-A-Spede" **adjustable speed drive,** has been published by the Louis Allis Co., 427 E. Stewart St., Milwaukee 1, Wis. The unit, available from 5 to 200 H.P., is a variable-voltage DC drive that usse AC as its power source. Applications such as machine tools, metal processing, textile, paper making, test stands, conveyors and the like are discussed and illustrated in the bulletin.

A **research and testing laboratory** designed for the solving of problems in drying, evaporation, extraction, mixing, crystallization and other related processes is described in Bulletin No. 381 recently published by Buflovak Equipment division of the Blaw-Knox Co., Buffalo, N. Y. The 10-page bulletin explains the operation of the customer laboratory and illustrates the services rendered in the search for answers to problems in the chemical, food, pharmaceutical and petrochemical fields.

A new bulletin describing the design and price information concerning the Dean Thermo-Panel coil manufactured by Dean Products Inc., 616 Franklin Ave., Brooklyn, N. Y. is now available. Price data bulletin No. 258 offers information on price estimating and describes the operation of the Thermo-Panel Coil unit.

BOOKS

LITERATURE ON FOOD RESEARCH AND TECHNOLOGY [1]

Commodities

Meat hygiene. V. E. Albertson, and others. New York, Columbia University Press, 1957. 527 p. (World Health Organization. Monograph series, no 33.) $10.00. Papers by sixteen of the world's foremost authorities on the subject.

The world's sugar, progress and policy. V. P. Timoshenko and B. C. Swerling. Stanford University, Cal., Stanford University Press, 1957. 376 p. (Stanford University. Institute of Food Research. Food, agriculture and World War II studies no. 12.) A detailed analysis of the problem of international sugar economy.

Food Engineering

Interdepartmental radiation preservation of food program, First report. Interdepartmental Committee on Radiation Preservation of Food. Feb. 1957. 31 p. $1.00. The Committee was established in May 1956 to develop methods of using ionizing radiation to preserve food. Order from Office of Technical Services, U. S. Department of Commerce, Washington, by number PB-131169.

Food Technology

Improved quality the key to increased utilization of meat. D. M. Doty and B. S. Schweigert. Chicago, 1957. 11 p. (American Meat Institute Foundation. Circular no. 40.) Apply.

United States standards for grades of frozen concentrate for lemonade. Washington, U. S. Department of Agriculture, Agricultural Marketing Service, 1957. 6 p. pap. apply. Effective Feb. 1, 1958, superseding standards in effect since December 19, 1953.

Peach hydrocooling, shipping and fungicidal tests. W. L. Smith and others. Washington, 1957. 20 p. (U. S. Agricultural Marketing Service. AMS 199.) apply. I. Tests of Pennsylvania peaches. II. Tests of South Carolina peaches.

Biological Sciences

Donnés générales sur la nutrition et l'alimentation. R. Jacquot, H. le Bars, and H. Simonnet. Paris, Baillière, 1958. The first volume of a projected nine volume encyclopedia of animal nutrition.

Hormones in blood. G. E. W. Wolstenholme and Elaine C. P. Miller, eds. London, Churchill, 1957. 428 p. (CIBA Foundation colloquia on endrocrinology, v. 11.) 56 s. Twenty one papers presented at the colloquium held in London in February 1957.

Chemical Sciences

The chemistry and biology of yeasts. Albert H. Cook, Editor. New York, Academic Press, 1957. 775 p. $22.00. Among other things covers yeast technology and yeast in relation to food spoilage.

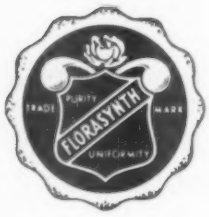
The chemistry of the steroids. W. Klyne. London, Methuen, 1957. 216 p. (Methuen's monographs on biochemical subjects.) 18 s. Written for those trained in biology or medicine without detailed material for the specialist.

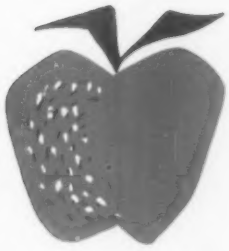
Industrial toxicology. Ed. 2, rev. Lawrence T. Fairhall. Baltimore, Williams and Wilkins, 1957. 326 p. $10.00. A study of the toxicity of many industrial chemicals, but does contain material on organic substances used as insecticides, fungicides, and germicides, which could be met with in food products.

Modern cereal chemistry. Ed. 5. Douglas W. Kent-Jones and A. J. Amos. Liverpool, England, Northern Publishing Company, 1957. 817 p. 105 s. Written with the aid of numerous experts in specialized fields.

Rapid testing of oil seeds for oil quality and iodine number of oil. M. H. Neustadt. Washington, U. S. Govt. Print. Off., 1957. 26 p. (U. S. Department of Agriculture. Technical bulletin 1171.)

[1] Material for this list should be sent to Dr. James G. Hodgson, Chief, Library Branch, Quartermaster Food and Container Institute for the Armed Forces, 1819 W. Pershing Road, Chicago 9, Illinois.





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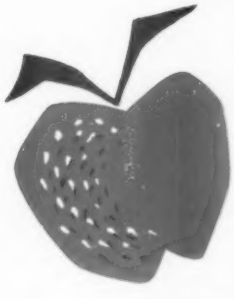

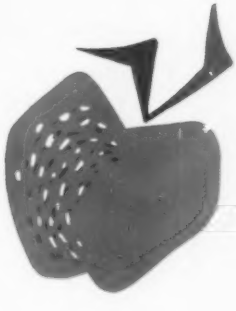

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Microbiological Standards for Foods. II.

What May Microbiological Standards Mean?[a]

F. S. Thatcher[b]

Laboratories of the Food and Drug Directorate, Ottawa, Canada

(Manuscript received August 30, 1957)

THE HIGHLY SUBJECTIVE TITLE of this assignment is indicative of the obtuseness of the subject. Any response to it must be largely a matter of opinion. The discrete formulation of that opinion requires that a diverse array of information be viewed in perspective. Attainment of this perspective involves careful thought to give appropriate weight to such multi-faceted considerations as (a) the degree of public health hazard engendered by a specific microbial content of different foods, (b) the significance, statistical and interpretive, of specific microbial determinations from such foods, (c) the factors of practicality and economics associated with the production of foods of specified microbial quality, (d) the validity of opinion concerning the significance of bacterial species traditionally inferred to indicate potentially harmful contamination, (e) the problems involved in enforcement of any postulated standard, and (f) an appraisal of the overall public benefit that may result from a rigid control of the microbiological content of food which the assessment of microbiological standards implies. A more detailed development of the pertinent factors has already been published *(15)*.

Subjective opinions will inevitably be influenced by the experience of the formulator. The viewpoint of an officer of an organization charged under law to do all in its power to assure that foods offered for sale in Canada shall be safe, wholesome, and non-fraudulent is herewith presented. This viewpoint is tempered by 10 years of experience in post-graduate teaching of the Microbiology of Foods and the Physiology of Microorganisms, by an intimate contact with some hundreds of food-processing establishments, together with a comprehensive picture of the microbiological content of many kinds of marketed food products. My remarks will apply to conditions in Canada, and, insofar as I understand them, in the United States—and with a minimum of reference to "commercially sterile" canned foods.

A cardinal principle

Before attempting an evaluation of microbiological standards for foods, I wish to impose a rigid limitation based on a concept which, to me, overrides all other considerations. I believe it to be a cardinal principle that a regulation with legal force is only tolerable if the regulation earns a significant degree of success in its objectives; these objectives must be of public benefit. Adherence to such a principle, quite apart from its more fundamental social values, would avoid the danger referred to by Ingram and Brooks *(8)* to the effect that "specialists might become too obsessed with microbiological standards for their own sakes."

It is assumed that one intention in the initial elaboration of microbiological standards for foods was to reduce the incidence of food-poisoning and food-borne infection.

In its starkest simplicity, a legally promulgated microbiological standard means only that a food which has a microbial content numerically in excess of an arbitrarily assessed figure may not be sold. The extent to which compliance with such arbitrary limits confers safety to foods is problematic. As recorded fact, of the approximately 1500 cases of typhiod epidemiologically attributed to consumption of cheese on this continent, the typhoid organism was rarely, if ever, isolated from this food *(1)*. Salmonellosis among infants has been attributed to coliform-free egg-products containing the causal Salmonellae in numbers less than one per gram. Powdered milk containing no viable staphylococci has given rise to food-poisoning of the staphylococcus syndrome, due to the presence of enterotoxin in the heat-processed food *(2)*. Standards specifying absence of any of these pathogens would have had little value. Furthermore, many pathogens, including *Brucella* and the food-borne viruses, are determinable in foods only by such tedious methods as to be impracticable to use as a routine means of control through standards specifying absence.

Conversely, if a food can be shown to contain pathogenic organisms or substantial numbers of the indicator species which, by tradition, are inferred to imply disease hazard, the probability that disease will result from consumption of such food is not accurately predictable. Experience in my present position teaches me that for many market foods such relationship would be expressed by a negative correlation of high order.

How useful are standards?

It is unjustifiable to impune the validity of the classical tradition that contamination of food with fecal organisms implies a risk of the presence of enteric pathogens. Nevertheless, it is appropriate to recall that the significance of such association was established when typhoid and dysentery were com-

[a] A contribution under an assigned title to the "Symposium on Problems in the Microbiological Analysis of Foods", held at the Annual Meeting of the Society of American Bacteriologists, Detroit, Michigan, 1957.

[b] Head, Microbiological Section.

mon diseases, and pandemics of cholera were not without their threat. The carrier rate was much higher than at present; the bacteriological control of water was practically nonexistent; the practice of hygiene in the production, distribution and storage of foodstuffs was primitive by modern standards; and refrigeration in retail stores and the home was largely restricted to the occasional ice-box. This is no argument to relax in the wholesome development that has taken place in recent years, but it does seem pertinent to recall the prevailing environment at the origin of the tradition and to realise that current epidemiological practice, public health engineering, water treatment, meat inspection programmes, the trend towards improved sanitary practice in food manufacture, and the almost universal use of refrigeration in the storage of perishable food in this part of the world, collectively confer a modified degree of hazard upon the established presence of small numbers of enteric bacteria as compared with the same degree of contamination of even 50 years ago. The question arises, is it sound to require that all foods should in effect reach the standard to be expected for pasteurized milk—as sometimes seems to be inferred—having in mind the relative degree of the probability for development of pathogens in the respective foods? An approach to the truth may well be prejudiced unless the factors just mentioned are appropriately weighed.

Continuing in similar vein, investigators in the Laboratories of the Food and Drug Directorate have found substantial numbers of coliforms, *Escherichia coli*, Paracolobactrum, *Proteus* and enterococci, in thousands of specimens of market food for which there has been no evidence that enteric disease has resulted. The bacteriological surveys carried out in the same laboratories have shown that Staphylococci may be found in certain foods with great frequency but with highly infrequent evidence of attendant food-poisoning.

Nevertheless, it is an established fact that a diversity of food-borne infections, bacterial and viral, *do* occur and that bacterial food-poisoning remains a public problem, albeit a comparatively minor one in relation to some others—atherosclerosis or traffic accidents, for instance.

These observations point to the indication that microbiological standards in market foods can only be of limited prophylactic value. Nevertheless, the occurrence of food-borne disease requires rational effort to reduce risk. The inference is aptly expressed by Tanner: "While a clean food is not necessarily safe, it is in a better position to be so than one which is consistently dirty" *(14)*. The role of government in public health is largely directed toward the securing of health and the prevention of disease rather than the treatment of illness. To the extent that microbiological standards are prophylactic, they could be constructed as lying within the scope of public health responsibility.

In addition to the public health aspect, the role of microorganisms in relation to *quality* of foods is pertinent. Insofar as the total numbers of organisms or numbers of specific physiologically distinctive groups present in foods can be indicative of a deterioration in quality or of a reduction in the duration of shelf-life, these numbers need to be controlled.

Practicality and economics

But let us return to the problem of practicality and economics. These factors apply both to the control agencies concerned as well as to the food producers or manufacturers. I know of no government agency with sufficient staff or facilities to provide for examination of the microbial content of *all* foods. I can foresee neither likelihood of success nor justification for the recruitment of the large number of bacteriologists and technicians that would be needed for any such undertaking. Neither can I foresee justification for the additional cost that would be attendant upon any wholesale demand that all foods should approach perfection insofar as absence of microorganisms is concerned. It follows, therefore, that the only foods that should be considered for possible control by legally enforced microbial standards are those which through experience are known to be particularly subject to causing illness or that possess peculiar properties that endow them with a propensity towards spoilage or causing illness.

Thus, new questions arise. Which are the foods the more likely to belong in these two categories; and if standards are to be applied, at what point are they more likely to be effective—at the factory, or at the retail-market level? Other speakers at this symposium have already stressed the importance that must be placed, when assessing the significance of the specific microbial content of foods, upon such factors as the nature of the foods, the normal method of handling and distribution, the relative degree of opportunity for multiplication or toxin formation, and the degree and thoroughness of cooking which will normally be given to such foods. These considerations apply further restriction to the possible usefulness of specific standards. For instance, in recent years extensive discussion has been published concerning the microbial content of frozen citrus juices—in part directed, one can assume, towards a forestalling of the establishment of microbial standards for these foods *(17)*. In my opinion, the vast amount of these foods that have been consumed with general consumer satisfaction and the lack of any evidence of food-borne infection or food-poisoning resulting from them would render such products among the last to be considered by the Department to which I belong, at least with any intent to set up and use microbial standards as criteria of their healthfulness. A quality standard aimed at assessing the level of vitamin C might be more significant.

New foods marketed in massive amounts need surveillance

On the other hand, an alert public health agency ought to be positively concerned about the microbial

content of comparatively new forms of processed foods for which it has not yet been possible to estimate their public health hazard based on experience. Any factor which changes the ecological balance of microflora in a non-sterile food presents a potentiality for a modified health or spoilage hazard. Food control agencies have a responsibility to be actively interested in the microbial quality of new foods marketed in massive amounts, especially when such foods appear to have received extensive handling during manufacture, and which, in the event of inadequate refrigeration represent an admirable medium for the multiplication of pathogens and spoilage organisms or for the elaboration of toxins. To illustrate, reference is made to the mass-produced frozen pre-cooked dinners, meat pies, poultry dishes and the like, and the growing trend towards the sale of factory-stuffed poultry. Although it is true that most manufacturers of these products recommend comparatively extreme cooking temperatures, nevertheless, the actual heating or cooking that they may receive in the consumer's kitchen may not be adequate to destroy all pathogens *(7)* and, of course, would not be expected to be effective in the destruction of staphylococcus enterotoxin. Further, the current rapid expansion of the frozen food industry tends towards the overtaxing of refrigerated storage, whether in transit, in stores, or in the home, so that the opportunity for these products to thaw, with attendant multiplication of bacteria, may be more frequent than it should.

My laboratory has recently shown that when turkeys were stuffed with a commercial brand of dehydrated "ready mixed" poultry stuffing that had been experimentally inoculated with spores of a toxigenic strain of *Clostridium botulinum* type A, and then frozen at −30° F., the toxin content of the stuffing in 24 hours after removal to room temperature was sufficient to kill every mouse tested, provided protective injections of antitoxin had not been administered. Enterotoxin also developed in stuffed turkeys inoculated with a toxigenic culture of *Staphylococcus*, though in this particular experiment not until 48 hours after removing from cold storage. A sparse *Salmonella* inoculum similarly multiplied to massive numbers *(3)*. This preliminary study did not allow determination of whether toxin formation occurred during the cooling period prior to freezing or during the period the specimens were held at room temperature after removal from frozen storage. It is recognized, also, that stuffing of different compositions may perhaps modify growth and toxigenesis by different bacteria, but the experiment is cited to point to the obvious potential hazards that may develop should contaminated foods of this kind be exposed for sufficent periods of time to temperatures that allow growth or toxigenesis either during processing or subsequent to freezing.

A recent market survey, made under my direction, of randomly purchased frozen pre-cooked dinners (for the most part produced in the United States) showed the frequent presence of coliform and paracolon organisms, enterococci, staphylococci and a large "total count". It is foods such as these last two items which might more logically receive public health control. But with regard to the stuffed turkeys, again the "sore thumb" of practicality introduces a problem. How feasible would it be to determine either *Clostridium botulinum*, *Salmonella*, *Stayphylococcus* or coliforms from such unwieldy and expensive specimens as stuffed turkeys? Bear in mind that it is highly likely that a focus of infection with any one of these groups may be localized within a small part of the stuffing, or in accord with our findings, in some crevice or membrane at the interface between the stuffing and the visceral cavity. This might suggest that effective control in such instances might well be directed to supervision of factory sanitation rather than to the microbial content of the marketed product. (Time-temperature relations at critical periods in the processing scheme are included in the concept of sanitation used here).

Control at the source

This brings us to a consideration of the rationale of what might be called "control at the source", that is, effort to minimize the probability of contamination at the factory. Control of food quality through microbial standards or any other mechanism at the retail level has many disadvantages. It is physically possible to examine only a minute fraction of the total foods marketed. Even if examination be restricted to a small number of individual products whose relative degree of hazard has been agreed to warrant such control, only a token sampling is routinely possible at present. Further, even if seriously sub-standard food were to be found, because of the time taken for effective microbiological analysis, the modern food distribution system will almost guarantee that much of that food would have been widely disseminated through the country and a substantial portion of it already consumed. My laboratory has proved the distribution of a specific 'phage type of enterotoxigenic *Staphylococcus* in a particular brand of cheese into each of 10 retail stores in each of 8 cities, extending across this continent *(16)*.

We should bear in mind that in Canada, and in the United States, a number of government agencies, state and federal, in departments of health and agriculture, already have some degree of power for the control of the total picture of sanitation in food factories. That the effectiveness of this control at present is limited, largely by lack of "man-power", must be admitted. The most effective means of securing healthfulness and high bacteriological quality of foods would evolve, I believe, from increased action within this concept of "control at the source" through a greater degree of sanitary inspection and insistence upon the practice of adequate hygiene throughout the factory. Further, I believe it would be desirable to discuss the value of limited microbial standards as a means of offering support to such a control system. Standards of microbial quality have a role in strengthening efforts to improve factory sanitation. Microbial

standards should be recognized as a tool conferring objectivity upon this long-term aspiration. Wide agreement exists that the major source of objectionable contamination of foods is within the factory, though notable exceptions occur. Several authors have suggested that standards of operation that are rational and specific for particular kinds of processing would need to be assessed. This assessment should preferably be made in my opinion, by industry-inspired codes. I believe that I express the general feeling of my Directorate in suggesting that choice of technological mechanisms and processes are the prerogatives of industry, not of control agencies. The essential requirement in food control on which government needs to be satisfied is that the food is produced under conditions which provide realistic precaution to minimize the risk of exposing food to contamination with propensity for causing illness to the consumer or which introduces other objectionable extraneous matater or which leads to spoilage.

Some indication of the adequacy of the total hygiene control within a factory may be estimated by bacteriological study of surfaces which contact food, and the potential usefulness of microbial standards of cleanliness within specific kinds of factories might be a worthy subject for discussion; but the overall effectivity of sanitation control will be revealed in large measure by the microbial quality of the product. The consumer has the right to expect that his food will be processed under hygienic conditions. General attainment of this condition in factories will involve the most effective insurance that marketed foods will be safe and wholesome. Observations from which similar inference may be deduced have been made by others *(2, 5, 6, 7, 10, 11, 12, 13)*.

The culpable "small minority"

The argument might well be advanced that progressive food manufacturers are already aware of the paramount significance of sanitation in the production of a safe product with a maximum shelf-life, and that their own internally applied bacteriological standards already provide an effective means of microbiological control.

There is no doubt that many progressive manufacturers apply internal standards probably more exacting than would be practicable to expect as an industrial norm. Experience shows, however, that many food processing establishments, particularly the smaller ones, make no attempt at routine control and have available neither a bacteriologist nor facilities for the bacteriological examination of their processing development or of the final product. It should be appreciated also, that throughout agriculture, and the dairy and food industries, production units of small capacity are commonplace. Bacteriological control at each of these small establishments would not be practicable. This lack of a controlled establishment is further aggravated, fortunately in a minority of instances, by the revelation of ignorance, carelessness, unethical action and gross abuse of elementary principles of hygiene. It is this small minority which will be expected to engender the greater public health hazard. It is this same minority who are more likely to need the spur of satisfying a *compulsory* requirement. Furthermore, it is our experience that even though routine control is carried out, in the event that a particular production "batch" of food may prove to be substandard there is no guarantee that such products will not be released on the market. Moreover, it is not an unusual experience to find that the control staff would welcome some form of legalistic definition to serve as a source of argument by the control personnel against a management unconvinced of, or unwilling to budget in accordance with, the paramount values of effective hygiene.

Canadian experience with a limited number of microbiological standards suggests that the need to maintain standards in order to meet legalistic requirements also aids in circumvention of potential hazards that may accrue through inadequate attention to sanitation during periods of extreme pressure induced by peak production loads, personnel problems, or even a competitive attempt to cut costs due to stress of market conditions. A recent review by Gibbons *(4)* suggests that the introduction of microbiological standards does exert a salutary stimulation towards improved quality selection and factory sanitation, particularly on the part of the more backward minority.

If one of the main values accruing to the establishment of standards can be shown to be a means towards encouragement of adequate sanitary practice and control, the question still arises—to what degree need such standards be legally promulgated. I have in mind a distinction between legally promulgated standards and what might be termed administrative standards which are not defined under law. Either form of standard, it seems to me, should be based on a mutually agreed and practicably attained quality satisfactory to both public health authorities and to the technical personnel of progressive industry. If, for specific foods with the health or spoilage implications already discussed, some agreement can be reached to the effect that the presence of a specified population of microorganisms can be validly interpreted as representing either a health hazard, an indication of a "breakdown" in proper sanitary control, or the use of unsound raw materials, then it is conceivable that administrative standards may offer an elasticity of approach favouring improvement by allowing for an interchange of the subjective judgements of the interested parties. In the event that improvement should not result within this orbit, it is still conceivable that corrective action could be taken either on a basis of the existence of a potential health hazard, or the use of microbial evidence to indicate manufacture or handling under unsanitary conditions. In Canada unsanitary conditions are defined in the Food and Drugs Act as "such conditions or circumstances as *might* contaminate a food . . . with dirt or filth or render the same injurious to health."

Restrict standards to specific foods

I do not believe that the potential benefits that can be derived from standards are sufficient to warrant general use for *many* foods. Rather, their application should be restricted to specific foods for which there is a rationale for anticipating significant hazards. The Food and Drug Directorate of Canada, would normally seek a basis for agreement on this last aspect after laboratory survey and through collaborative contact between the enforcement agencies and representatives of the pertinent industry, through its Associations, having in mind that microbial standards ought to be based on a rational regard for the degree of hazard to be expected from the specific foods for which they are intended and the probability of attainment within economic limitations. Further, as already discussed, any promulgated standards should be based on determinative methods adequate for their purpose and must be practicable in attainment by the processor *(15)*. They should preferably be supported with a sufficiency of power to allow their administration with a degree of elasticity that can accommodate to the statistical variability of bacteriological determinations and the many extenuating circumstances that in specific instances should properly be considered, and allow the kind of subjective decision that leads to a harmony based on mutual respect.

Some needed studies

At present, mutual agreement would be expedited if solutions to the following problems were available. First a statistical study is needed to relate the incidence of illness to the presence of specific indicator species in particular foods. This requires both a comparative determination of the presence of indicators and pathogens in foods and an epidemiological analysis of outbreaks of food-borne illnesses in relation to the prevailing bacterial content of specific food products. As a prerequisite, a comparative study is desirable to ascertain the degree of confidence that is warranted in the assumption that the presently recognized indicators (coliforms, *E. coli*, enterococci, *Clostridium perfringens*) do indeed denote fecal contamination. Other desirable studies, perhaps less pressing, but important nevertheless, include an appraisal of the effects of processing and of storage (including freezing, refrigeration, sublethal heat treatment, anaerobiosis, ecological competition, antibiotics, etc.) on properties of specific bacterial pathogens as germaine to public health, with emphasis upon such factors as longevity, virulence, toxigenicity, and mutability. The environmental and nutritive factors conducive to elaboration of toxins require thorough study.

Prophylactic mechanism for protecting the consumer

In conclusion, bacteriological standards for foods are not justified for *widespread* use at the market level, but should be restricted to apply to specific foods for which there is reason to expect hazards to health or of spoilage. Within this context microbial standards may prove to be of public benefit insofar as they offer a prophylactic mechanism for the protection of the consumer. They represent a means of estimating at what level of contamination pressures need to be exterted to minimize risk of illness as well as providing an objective basis for revealing inadequate sanitation from which other action towards improvement may be invoked, preferably through stimulation towards voluntary improvement or through legal action in the instance of persistent default. If created in a context of careful perspective and used wisely, their greatest potentiality for public benefit is as a tool in the hands of both processor and enforcement agencies towards improved "control at the source." As a corollary to any such programme, I would advocate a vigorous campaign to educate the public in the safe handling of foods, since the ignorant abuse of perishable foods by the retailer, the restaurateur or the housewife, is as much conducive to development of food-poisoning and spoilage as is initial or factory-contributed contamination.

In contradistinction to the foregoing argument and as discussed elsewhere *(15)*, it is appropriate to recall that highly primitive conditions of hygiene apply in some parts of the world, wherein intestinal disease is common and the carrier rate is extremely high. As a safeguard against the hazards attendant upon international transport of foods produced under such conditions, and as a protection against the export of substandard foods from the more technologically advanced regions, the use of microbiological standards for "vulnerable" foods in international commerce may be more widely applicable.

LITERATURE CITED

1. Anon. Federal Security Agency: Food and Drug Administration. "Findings of fact" citations. *Federal Register*, **14** (77) 1960–1975 (1949).
2. Dack, G. M. Evaluation of microbiological standards for foods. *Food Technol.*, **10**, 507–509 (1956).
3. Erdman, I., and Thatcher, F. S. (Unpublished data from the Microbiology Section, Food and Drug Directorate, 1957).
4. Gibbons, N. E. Microbiological standards adopted for foods in Canada. Cong. Internat. Microbiol., Rome, (Atti), **7**, 288–292 (1953).
5. Goresline, H. E. A discussion of bacteriological standards for dehydrated foods. *Am. J. Public Health*, **37**, 1277–1283 (1947).
6. Heller, C. L. Bacteriological standards for perishable foods. (b) Manufactured meats. *Royal San. Inst. J.*, **72**, 396–403 (1952).
7. Husseman, D. L. Effect of cooking on the bacteriologic flora of selected frozen pre-cooked foods. *J. Am. Dietet. Assoc.*, **27**, 855–858 (1951).
8. Ingram, M., and Brooks, J. Bacteriological standards for perishable foods. (d) Eggs and egg-products. *Royal San. Inst. J.*, **72**, 411–420 (1952).
9. Price-Davies, W. Bacteriological standards for perishable foods. *Royal San. Inst. J.*, **72**, 391–395 (1952).
10. Rayman, M. M., Huber, D. A., Zaborowski, H. Current microbiological standards of quality for precooked frozen foods and their basis. In *Precooked Frozen Foods. A Symposium.* (1955). Quartermaster Food and Container Institute of the Armed Forces, Chicago. 76 pp.
11. Rowlands, A. Bacteriological standards for perishable foods. (c) Milk and dairy products. *Royal San. Inst. J.*, **72**, 404–410 (1952).

12. SAVAGE, W. Problems of *Salmonella* food-poisoning. *Brit. Med. J.*, **1**, 317–323 (1956).
13. SLOCUM, G. G. Bacteriology of crab-meat as related to factory sanitation. Assoc. Food and Drug Officials, U. S., *Quart. Bull.*, **19** (2) 43–49 (1955).
14. TANNER, F. W. Quality in foods. *Food Technol.*, **3**, 179 (1949).
15. THATCHER, F. S. Microbiological standards for foods: their function and limitations. *J. Applied Bact.* (Gt. Brit.), **18** (3) 449–461 (1955).
16. THATCHER, F. S., SIMON, W., AND WALTERS, C. Extraneous matter and bacteria of public health significance in cheese. *Can. Public Health J.*, **47**, 234–243 (1956).
17. VAUGHN, R. H., MURDOCK, D. I., AND BROKAW, C. H. Microorganisms of significance in frozen citrus products. *Food Technol.*, **11**, 92–95 (1957).

Studies on Microbiological Methods for Predicting Shelf-Life of Dressed Poultry[a]

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A QUICK METHOD of determining sanitary conditions in poultry dressing plants is needed and also a method for predicting the shelf-life of dressed poultry. Because sanitary conditions in the plant and shelf-life of the product are associated with the microbial populations of the product, a quick measurement of the total population or a selected section of the total population may have merit.

Walker and Ayres *(6)* have demonstrated that populations of 1×10^7 to 1×10^8 on the skin of dressed poultry indicate an unacceptable product. The populations were determined by the swab technique, culturing an area of 2 cm.^{2} Ayres, Walker, Fanelli *et al. (1)* demonstrated that the microbial population on the refrigerated product (4.5° C.) becomes a psychrophilic population during storage. The psychrophilic population after 12 days storage was 90% *Pseudomonas-Achromobacter.*

Various methods of measuring surface populations have been used, ranging from a surface sampling by rubbing a cotton swab over a measured area, to removing a narrow strip of skin or tissue as reported by Butler *(3)*. Ayres *et al. (1)* in addition to a swabbing technique, used a rinse method wherein the birds were rapidly dipped 50 times into sterile water. The two methods gave roughly similar results, although the rinse count was always lower.

This study was made to determine the relationship of microbial populations and shelf-life of ready-to-cook poultry in terms of consumer acceptance.

METHODS

Swab technique. The swab on a wooden applicator consisted of firmly twisted cotton forming a swab about 3/16 in. in diameter and ¾ in. long. The swabs were sterilized by dry heat. Prior to swabbing, each swab was moistened in sterile saline and pressed free of excess moisture. Approximately 4 sq. in. of the skin surface of each half bird, just above the thigh, was swabbed 3 times in different directions, rotating the swab in the process. The applicator stick was broken off aseptically about 1 in. above the swab, the swab being placed in a tube containing 10 ml. of sterile saline. The tube was vigorously shaken by striking it against the palm of the hand for 2 minutes to disperse the cotton. Serial dilutions were made from the diluent and plated in the appropriate medium.

Rinse methods. Each half bird was placed aseptically in a sterile 1 gallon glass jar and 400 ml. of sterile saline was then added. This volume was chosen in order to have adequate washing action; it approximates the average weight of the half birds. The jar was then vigorously shaken by means of a reciprocal shaker for 2 minutes at 200 oscillations per minute. Serial dilutions of the diluent were made for plating purposes. One ml. of the diluent was routinely used as an inoculum in the tube test procedure.

Tryptone glucose extract agar (TGE) was employed as a plating medium for determining total bacterial count from both rinse and swab diluents. The medium was held at 45–48° C. before pouring to avoid destroying the thermal sensitive psychrophiles. Plates were made in triplicate for each serial dilution and incubated at 20° C. and 4.5° C. When the plates were incubated at 20° C. for 72 hours, growth of both gram positive and negative mesophilic and psychrophilic bacteria occurred. When the plates were incubated at 4.5° C. for 7 days only psychrophiles developed. This procedure was done in accordance with *Standard Methods for the Examination of Dairy Products* (10th ed.).

A selective medium developed by Broitman *(2)* for the rapid enumeration of psychrophilic organisms from milk was

[a] Scientific Paper No. 2135 from the Michigan Agricultural Experiment Station.

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adopted for use in this study. The medium, designated Phytone-Nacconol agar (PNA), has the following formula:

Phytone	20.0 g.
Yeast extract	5.0 g.
KH_2PO_4	0.1 g.
K_2HPO_4	5.0 g.
Nacconol NRSF	1.0 g.
Agar	15.0 g.
Distilled water	1000 ml.
pH	7.5

Nacconol, NRSF, an anionic wetting agent, was used in a concentration of 1–1000 to inhibit the growth of gram positive mesophilic bacteria. Prior to pouring, a sterile solution of 2, 3, 5 triphenyl tetrazolium chloride was added to give a final concentration of 1–10,000. Broitman *(2)* found, almost without exception, that all psychrophiles reduced tetrazolium chloride from colorless to red, thus facilitating the counting of the colonies. PNA was tested by Broitman *(2)* against the procedure for enumerating psychrophiles in *Standard Methods for the Examination of Dairy Products* (10th ed.) and was found to be statistically similar. Incubation of the triplicate plates was at 20° C. for 72 hours. This time and temperature facilitated a comparison with the total count obtained on TGE at 20° C. for 72 hours.

A broth medium was developed for the purpose of rapidly detecting psychrophilic bacteria present on the surface of dressed poultry. The broth designated Phytone-Nacconol broth (PNB) was designed to be selective for gram negative organisms, and to indicate bacterial growth by the reduction of the triphenyl tetrazolium chloride. The reduction of this indicator is accompanied by a change from a colorless state to a pink to reddish color. The PNB medium was formulated in 2 parts, the base medium and the indicator solution. The base medium consists of the following ingredients:

Bacto skim milk	100 g.
Phytone	20 g.
Yeast extract	5 g.
Distilled water	800 ml.

The indicator solution consisted of the following:

K_2HPO_4	5 g.
KH_2PO_4	0.1 g.
2,3,5, triphenyl tetrazolium chloride	0.1 g.
Nacconol NRSF	1.0 g.
Distilled water	100 ml.

Base medium was prepared, brought to a pH of 7.3 with NaOH and dispensed in 8 ml. quantities in ¾ in. test tubes. The tubed media in test tube racks was autoclaved at 116–117° C. for 10 minutes. This time and temperature was found to produce sterile medium without resulting caramelization. The pH after sterilization was 6.8. The indicator solution was sterilized at 121° C. for 15 minutes in a standard 100 ml. dilution blank wrapped in aluminum foil.

Bacto skim milk was employed in the base medium for the dual purpose of producing a good nutrient and offering an opaque background as a contrast for the color reaction. After an extensive screening of 10 peptones, Broitman *(2)* found phytone to be the most suitable. Yeast extract was added to stimulate growth of representatives of four psychrophilic genera, namely:

Pseudomonas fluorescens,
Achromobacter superficiale,
Alcaligenes viscosus, and
Flavobacterium rhenanus.

A phosphate buffer system was used to bring the final pH to 7.3, about the optimum pH level for these organisms. A series of comparative experiments was then made with the previously mentioned organisms to determine the most suitable composition for the medium. Thus skim milk (10%); skim milk (10%) and phytone (2%); skim milk (10%) and yeast extract (0.5%); and skim milk (10%) with phytone (2%) and yeast extract (0.5%) were compared.

Determinations of the growth rates of these organisms were made according to the method of Darby and Mallmann *(4)* using a minimal inoculum and recording the early phase of growth. A 24-hour culture of each organism was transferred each day for 3 days on Brain-Heart Infusion agar slants at 20° C. The comparative media were prepared in ¾ in. diameter test tubes and autoclaved at 116–117° C. for 10 minutes. Sterile phosphate buffer was added aseptically to all media at the time of inoculation. A set of 4 tubes was inoculated for each medium using a dilution that gave 50 to 100 organisms per ml. One tube from each set was plated at each time interval of 0, 3, 6, and 9 hours on TGE agar and incubated for 72 hours at 20°C.

The studies indicated that the combination of skim milk, phytone, and yeast extract gave equal growth with the *Achromacter* sp. compared to any of the other combinations. This same combination gave equal or better growth with the *Pseudomonas* sp. and *Alcaligenes* sp., and consistently better growth with the *Flavobacterium* sp. compared to any of the other combinations tested.

From these results a PNB medium was formulated as previously described, and used as follows to test the microbial population present on the surface of ready-to-cook poultry: At the time of sampling the rinse diluent, 1 ml. of the indicator solution was added aseptically to each base medium tube. Then 1 ml. of the rinse diluent was added to the same tube which was rapidly swirled and incubated at 20° C. The final pH was 7.3. Duplicate tubes were run for each sample tested. Control tubes containing the base medium and indicator solution but uninoculated were also incubated. A positive reaction was considered to be a deep pink to red color throughout the medium. Observations were made occasionally until the first detectable sign of a color change was apparent at which time the tubes were checked every three hours until a definite positive test developed.

Certain precautions must be taken in handling tetrazolium salts. Many, if not all, tetrazolium salts are sensitive to light and will turn pink in solution if exposed to ordinary daylight or yellow artificial light. For example, exposure of the complete PNB medium for 2 hours with yellow artificial light (100 watt bulb) gave a pink color. However, exposure of similar tubes to fluorescent light for 2½ days gave no change in the medium. Therefore, to avoid light sensitization, the indicator solution was always protected from light and the complete medium constituted immediately before testing the various samples. In this connection, uninoculated control tubes handled in the same manner as inoculated tubes were found to be stable in a dark incubator for as long as 3 weeks. At this time, they were usually discarded because of some precipitation and not because of any color change.

Another method also adopted for use in this study consisted of a surface plating technique developed by Mallmann and Broitman *(5)*. This procedure has distinct advantages over the routine pour plate technique in greatly reducing both the incubation time and materials.

Media previously described were employed in this drop plate method with the exception of incorporating triphenyl tetrazolium chloride in the TGE agar (1–10,000) final concentration, to facilitate counting colonies. Drop plates of TGE agar were incubated at 20° C. for 24 to 30 hours and at 4.5° C. for 5 days. The PN agar plates were incubated at 20° C. for 24 to 30 hours. Prior to inoculation, the plates were poured, allowed to harden and then dried at 37° C. for a minimum of 4 hours in an inverted position with the lid slightly ajar to facilitate drying.

Suitable dilutions of the rinse diluent were made so that by using 0.01 ml. or 0.05 ml. the colony counts obtained were in the range of 50 to 100. The prepared plates were simply sectored by scoring the undersurface of each plate with a wax pencil. Routinely 3 sectors were used although more could be made on each plate with ease. Thus each dilution was made in triplicate. The inocula were introduced on to the surface of the agar plate in .01 and .05 ml. quantities using 0.2 ml. sterile pipets graduated in 0.01 ml. The plates were allowed to set at room temperature for about 20 minutes after inoculation to allow absorption of the inocula drops and then incubated at the appropriate temperature. After incubation the plates were observed with a binocular microscope by means of oblique illumination at a magnification of 6.6x.

RESULTS AND DISCUSSION

Past experience with the swab sampling method has not been satisfactory as results were too variable. Sampling is limited to an area of 4 in.^{2} and the removal of bacteria from the surface is variable due largely to inability of the operator to apply the same pressure and moisture contents in the swab. A method wherein bacteria would be removed from surfaces of the bird, including interior areas as well as exterior, should give a more representative sampling of the total surface pollution.

Accordingly, the rinse technique previously described was compared with the swab technique. The results of this comparison are presented in Figure 1.

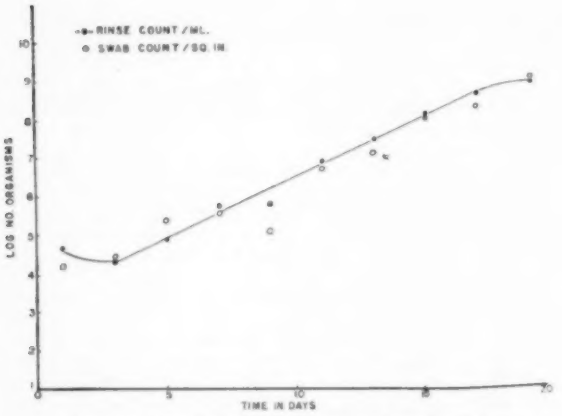

Figure 1. Total rinse count vs. total swab count.

These results represent sampling of half sections of fryers stored at 2° C. for 20 days. The 20 halves were prepared at one time and stored in crushed ice throughout the experiment. Results reported were total bacterial counts on TGE agar incubated at 20° C. for 72 hours. After 72 hours storage the counts obtained by the rinse procedure gave a constantly increasing population up to 17 days storage. Swab counts varied considerably from sample to sample, but in general the counts paralleled the rinse counts.

For research purposes, the rinse procedure is the more dependable technique and was adopted for this study. It could be used with slight modification for plant control purposes.

Weights of the halves varied considerably, ranging from 404 g. to 682 g. Figure 2 presents data on total population per 1 ml. rinse compared to total population per 1 g. body weight. The results are practically the same as might be expected in that the difference in surface area between the 2 extremes in weight is not very great. Because no significant differences occur, there is no need to adjust the total rinse counts by the body weight of the sample. All results reported are total rinse counts.

Broitman *(2)* found that a 20° C. count on PNA has proved successful in measuring the psychrophile population in pasteurized milk because all gram positive organisms present that would grow at this temperature are inhibited by the Nacconol. Weber *(7)* found that practically all psychrophiles present in pasteurized milk will grow at 20° C. Whether or not this would be true of the bacterial population of the skin of dressed birds could only be ascertained by bacteriological testing. Figure 3 presents the popu-

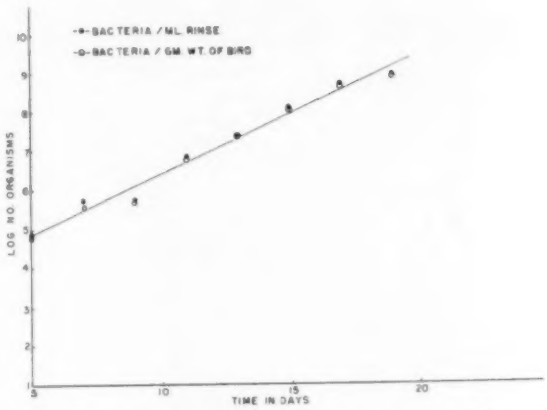

Figure 2. Total bacteria/ml. rinse vs. total bacteria/gm. wt. of bird.

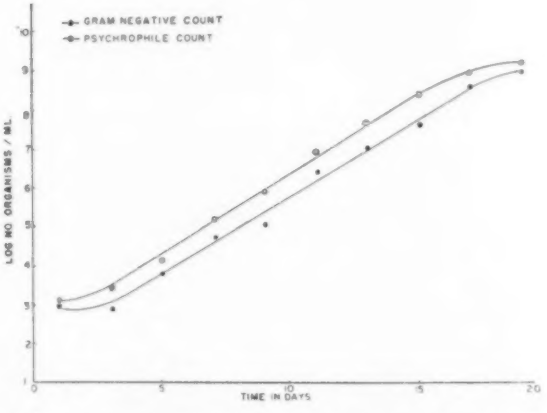

Figure 3. Gram negative bacterial count vs. psychrophile count.

lation obtained on PNA at 20° C. in 3 days and those obtained at 4.5° C. for 7 days. The 2 populations yield parallel counts at all stages of storage, although the 4.5° C. count is consistently higher. Both methods evidently measure the same population. Inasmuch as 20° C. PNA method takes only 3 days, it is obviously the better procedure for measuring the psychrophile population.

In the next series of tests the total population obtained on TGE medium at 20° C. in 72 hours was compared with the 4.5° C. TGE count at 7 days. These tests were made to determine the number of organisms that might be present that were not detected on the 20° C. PNA medium. The data are presented in Figure 4. Total count on the initial examinations prior to refrigeration of the birds was much higher

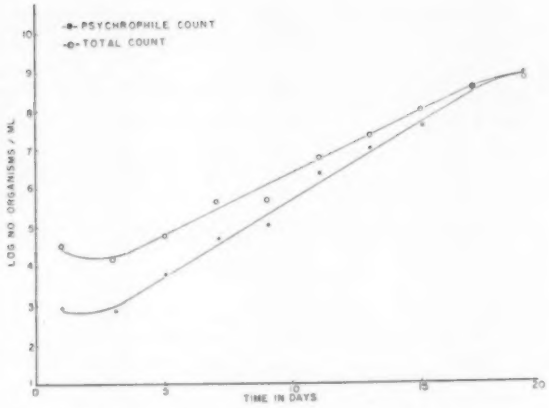

Figure 4. Total count vs. psychrophile count.

than the psychrophile count, but during storage the differences became less until at the time of spoilage, the counts were identical. Some of the organisms detected on the total count determination grew to some extent during storage; however, the psychrophile counts obtained on TGE at the 4.5° C. or on PNA at 20° C. appear the more representative of microbial population.

As previously stated, Broitman *(2)* developed a color test for predicting the shelf-life of pasteurized milk stored at 4.5° C. Inasmuch as it has been demonstrated that the 20° C. PNA measures the psychrophile population, then the PNB test should serve as an indicator of the approximate population by the time necessary for reducing the tetrazolium. In Figure 5

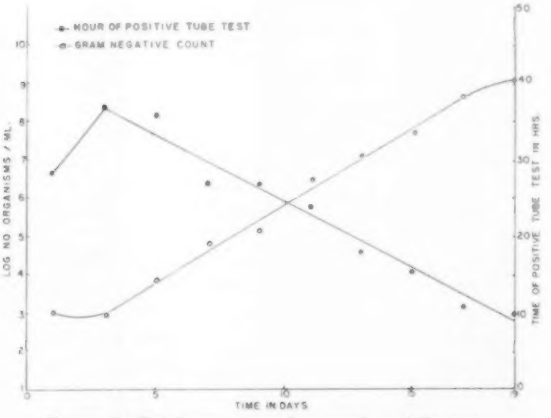

Figure 5. Total gram negative count vs. tube test.

are presented graphs of the 20° C. PNA counts and the reduction times of the PNB tests. A close relationship existed. This was characteristic of the many comparative tests made during this study including birds treated with chlortetracycline.

In the next series of tests, comparisons were made of the PNA 20° C. counts and the raw odor score. The raw odor score was used as a measurement of spoilage rather than cooked taste scores because it detects an earlier degree of spoilage that more closely measures consumer acceptance.

Results are presented in Figure 6. On the twelfth day the product was acceptable as measured by the

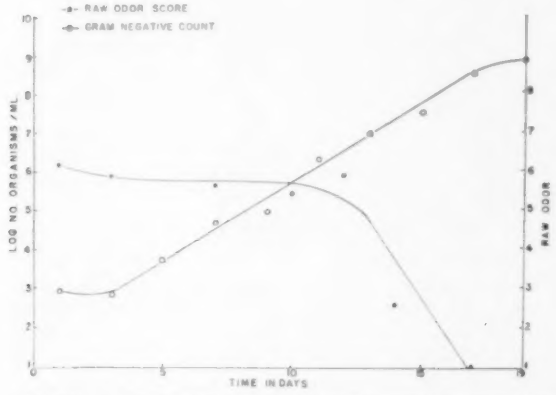

Figure 6. Comparison of gram negative count vs. raw odor score.

raw odor score, but the psychrophile population was approaching a count of 1×10^7. On the fourteenth day the product was rejected by all panel members as unacceptable and the bacterial population was 1×10^7. This relationship has held on all tests made on both antibiotic treated and untreated birds.

A comparison of the raw odor score and the PNB test is presented in Figure 7. An examination of the previous charts reveals a parallel relationship between the raw odor score and the PNB test reduction time.

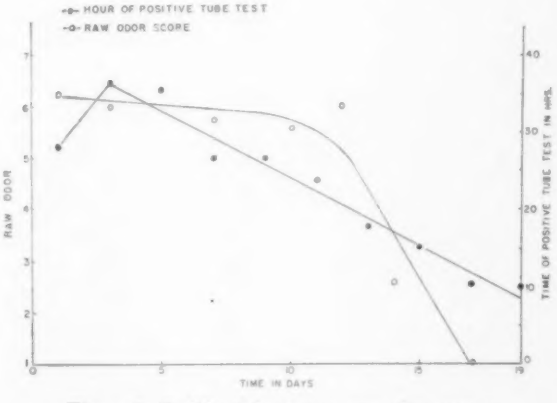

Figure 7. Positive tube test vs. raw odor score.

Thus, two methods of evaluating spoilage populations on dressed poultry are presented. These methods offer a quick evaluation for determining sanitary quality. One method, the PNA 20° C. either pour or drop plates, yields accurate bacterial populations and the second, the PNB reduction test, offers an approximation technique, somewhat comparable in accuracy to the resazurin test in milk. Both tests offer means

of evaluating sanitation practice in dressing plants. Obviously, a psychrophile count of 1×10^3 or a PNB reduction time of 24 hours or more indicates a sanitary operation. In the series of tests presented, the shelf-life of untreated birds was 12 days at 4.5° C.

Shelf-life of a product can possibly be predicted but either test cannot be used until after 72 hours of storage. No increase or a reduction in bacterial population in the first 72 hours occurs as measured by all tests. From this time, the increase in population is a straight line function so that population could be estimated and on the assumption that a psychrophile population of 1×10^7 indicates spoilage, then the shelf-life could be predicted.

The PNB reduction test could be used in like manner in that a reduction time of 36 or more hours after 72 hours storage would indicate a shelf-life of approximately 10 days. Although tests made with treated and untreated poultry dressed in the University dressing plant and 2 series of experiments in a commercial plant gave comparable results, many more tests would have to be made to prove the methods for predicting shelf-life and to establish standards. The investigators are hopeful others will test these methods for this purpose.

SUMMARY

A new method for determining psychrophilic populations on dressed poultry by the use of a Phytone-Nacconol medium incubated at 20° C. for 72 hours by either the pour or drop plate technique is presented.

An indicator reduction test using a Phytone-Nacconol tetrazolium medium is also presented for detecting insanitary plant operations and also a possible means of predicting shelf-life.

A total immersion method of determining bacterial population of the skin of dressed poultry was found more accurate than the swab technique.

LITERATURE CITED

1. Ayres, John C., Walker, Homer W., Fanelli, Mary Joanne, King, Albert W., and Thomas, Fred. Use of antibiotics in prolonging storage life of dressed chicken. *Food Technol.*, **10**, 563–568 (1956).
2. Broitman, Selwyn A. Methods for estimating the psychrophilic populations and keeping quality of milk. (Ph.D. thesis, Michigan State Univ., 1956).
3. Butler, O. D. Some causes and measurements of color change in fresh retail meat. (Ph.D. thesis, Michigan State Univ., 1953).
4. Darby, C. W., Mallmann, W. L. Studies on media for coliform organisms. *J. Am. Water Works Assn.*, **31**, 689 (1939).
5. Mallmann, W. L., Broitman, S. A. A surface plating technic for determining bacterial population of milk. *Am. J. Public Health*, **46**, 1018 (1956).
6. Walker, H. W., and Ayres, John C. Incidence and kinds of microorganisms associated with commercially dressed poultry. *Appl. Microbiol.*, **4**, 345–350 (1956).
7. Weber, Frederick, Jr. Identification and physiological studies of psychrophilic microorganisms in milk. (Ph.D. thesis, Michigan State Univ., 1956).

Statistical Development of Objective Quality Scores for Evaluating the Quality of Food Products

Development of the Scoring Scales*

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(Manuscript received September 5, 1957)

IN THE PAST 10 TO 15 YEARS, much attention has been given to developing objective methods for assessing subjective quality measurements. Smith *(10)*, Planck *(6)*, Hopkins *(1)*, and Sheppard *(8, 9)* have directed their efforts toward defining stable grading and scoring procedures for the quality characteristics of foods. Scott Blair, and Coppen *(7)*, Hopkinson *(2)*, and Kauman, Gottstein, and Lantican *(4)* have contributed valuable information, in general, toward the quantification of subjective measurement data in other fields.

The solution to the problem of developing a stable scoring system for subjective quality characteristics lies in two fields: psychology and statistics. Psychology explains and describes the subjective quality response of sensory perception when an objective stimulus is applied. Statistical methods quantify the subjective response, describe the relationship between the objective and subjective quality scales, and formulate the precision of the subjective judgments.

The purpose of this paper is to demonstrate the usefulness of standard statistical techniques in developing an objective scoring system for grading the subjective quality characteristics of foods. In this presentation, the authors are concerned only with the statistical aspects of the problem.

Objective vs. subjective scales as a measure of food quality. Product quality characteristics such as color, consistency, and clarity can be measured by objective and precise physical methods in the laboratory. However, these physical methods are sometimes expensive and time consuming when applied to the control of production processes. In these instances, visual and other sensory methods of evaluating product characteristics are commonly substituted for the more costly instrumental methods. Furthermore, physical measurements may or may not accurately reflect human response to a food quality characteristic. Certain other food characteristics such as flavor and odor cannot, as yet, be successfully measured by physical instruments; human response (sensory measurement) is still the best means of measuring flavor and odor characteristics.

The main difficulties encountered in the use of subjective sensory scales is their instability or tendency to drift in meaning with time and with judges. This problem is a serious one in that a numerical degree of failure must represent the same physical quantity at all times. Furthermore, the same subjective degree of failure must represent the same sensory response in all persons who are judging the same sample.

In developing a stable and objective scoring system, this problem is minimized if the scoring system is developed with the aid of simple and standard statistical procedures. To prevent the subjective scoring scale from drifting, it is necessary to anchor this scale to known physical measurements and to correlate assigned quality scores directly with the subjective scale, if the product attribute is not measurable by physical means. The relationship between the subjective scale and the physical scale can easily be established by a standard statistical method: regression by the method of least squares. The precision or the reproducibility of judgment and scoring data can also be easily assessed by a second standard statistical method: the analysis of variance. Objective quality scores can then be calculated based on the objective-subjective relationship. Finally, a series of standard samples may be prepared, based upon the objective-subjective relationship determined by the statistical methods. These standard samples must be used to "anchor" the degree of failure grades assigned by the judging panel in future scorings of the quality characteristics and are an integral part of the scoring system. When natural standards cannot be preserved, artificial standards may be prepared by matching these to the natural product characteristics.

Statistical development of the objective scoring system. The statistical development of an objective scoring system for color and clarity of a beverage product is illustrated in the following example.

EXPERIMENTAL

A dye solution in the color range of the natural product was prepared. Measured amounts of a darker dye solution were then added in equal increments to simulate a darkening of the color of the beverage product.

The quality characteristic of clarity was simulated by adding equal increments of a colloidal substance to a dye solution representing the normal color of the beverage. It is assumed

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that the range of product acceptability was included within the range of the color and clarity samples. It is assumed that human response to the artificial beverage color is directly correlated with human response to the natural color of the beverage. The color and clarity series were terminated at the point of assumed product rejection. Five color increments and six clarity increments were included in the series of samples. In actual practice, the clarity samples must be prepared over the full range of color samples.

A panel of three judges was asked to grade the samples numerically using the following subjective degree of failure scale *(3)* for both quality characteristics:

Subjective numerical grade	*Descriptive term*
0	No failure, perfect color or clarity
1	Very slight darkening or turbidity
2	Slight darkening or turbidity
3	Moderate darkening or turbidity
4	Bad darkening or turbidity
5	Very bad darkening or turbidity

Several days later the judges were asked to regrade the same samples to obtain the reproducibility or precision of the judging panel.

RESULTS AND DISCUSSION

The data from the series of samples are given in Table 1.

The analysis of variance of the degree of failure data resulting from the color judgments is shown in Table 2.

TABLE 1

Data obtained by a panel of three judges on grading five simulated beverage samples for color and six simulated beverage samples for clarity

	Judge 1 Trial		Judge 2 Trial		Judge 3 Trial	
	1	2	1	2	1	2
Color: Mls. of Dye						
4	0.7	0.5	0.4	0.8	0.7	0.4
8	1.5	1.9	1.7	1.5	1.5	1.8
12	3.0	2.7	2.9	2.5	2.8	2.6
16	3.6	3.9	3.5	3.8	3.8	3.6
20	4.8	4.5	4.5	4.9	4.6	4.8
Clarity: Mg. Colloidal Substance						
0.5	0.5	0.5	0.5	0.2	0.2	0.5
2.0	1.5	2.0	1.6	1.6	2.0	2.0
3.5	3.0	3.2	3.2	3.0	3.0	3.2
5.0	4.1	4.1	4.3	3.8	4.3	4.1
6.5	4.8	4.5	4.5	4.7	4.7	4.4
8.0	5.0	4.8	4.9	4.9	4.9	5.0

The analysis of variance showed that the 3 judges were grading the color samples in the same manner since there was no significant difference between judges nor were there any significant interactions. There was no learning factor in this series of samples since there was no significant difference between trials. The relationship between the degree of failure and the amount of added dye could be represented by a straight line since only the linear component of the between sample mean square was significant. The reproducibility of one measurement from any one judge was ±0.52 units of failure on the subjective scale.

TABLE 2

Analysis of variance—degrees of failure for color (No turbidity present)

Source of variation	Sum of squares	Degrees of freedom	Mean square	F ratio
Between judges	0.020	1	0.010	$F < 1$
Between trials	0.003	1	0.003	
Between color samples	63.090	4	15.773	477.970***
Linear component	63.040	1	63.04	1910.303***
Quadratic component	0.050	1	0.050	1.515NS
Cubic and higher component	0	2	0.	.....
Pooled Residual	0.727	22	0.033	.....
Interactions:				
Judges x trials	0.029	2	0.015	$F < 1$
Trials x samples	0.217	4	0.054	$F < 1$
Judges x samples	0.040	8	0.005	$F < 1$
Residual	0.441	8	0.055	
Total	63.84	29		

Critical Level = 1%; ***Significant at the 0.1% level; NS—Not significant. Reproducibility (P = 99.73%) = ±0.52 degrees of failure for one measurement from any one judge.

Following the analysis of variance of the color data, the average subjective color grades were plotted against the amount of added dye as is shown in Figure 1. The linear regression for the data was calculated by the method of least squares. The equation for the line was: Estimated degree of failure = 0.2571 mls. dye − 0.4152. The analysis of variance for the linear regression is shown in Table 3.

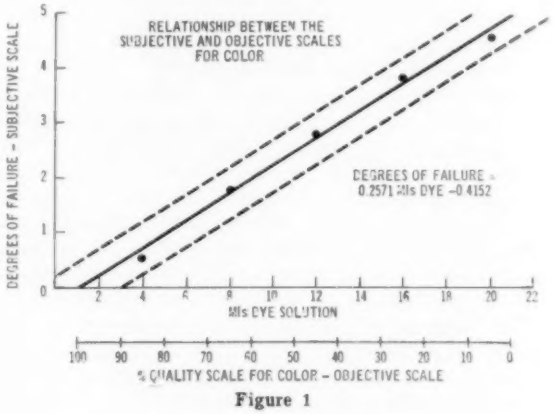
RELATIONSHIP BETWEEN THE SUBJECTIVE AND OBJECTIVE SCALES FOR COLOR
DEGREES OF FAILURE - SUBJECTIVE SCALE
DEGREES OF FAILURE = 0.2571 Mls DYE -0.4152
Mls DYE SOLUTION
% QUALITY SCALE FOR COLOR - OBJECTIVE SCALE

Figure 1

TABLE 3

Analysis of variance for the linear regression of degrees of failure for color darkening on amount of added dye

Source of variation	Sum of squares	Degrees of freedom	Mean square	F ratio
Due to linear regression	62.964	1	62.964	2098.800***
Deviations from regression	0.126	3	0.042	1.400NS
Residual	0.750	25	0.030	
Total	63.84	29		

Critical Level = 1%; ***Significant at the 0.1% level; NS—Not significant.

This analysis shows that the color data were satisfactorily represented by a straight line within the range of the data since the regression was significant, while the deviations from the linear regression were not significant.

The objective quality scores for the quality characteristic of darkening of color were obtained by dividing the range covered by the regression of the samples of the adedd dye solution, 1.9 to 21.0 mls., inclusive, into one hundred equal parts . This per cent objective quality scale is shown in Figures 1 and 3. A subjective degree of failure for darkening of the color of a beverage was converted directly into an objective quality score. Standard samples for darkening of color were prepared from the relationship shown in Figures 1 and 3:

Degree of failure	*Ml. of dye solution*	*Objective quality score*
0	0	100
1.0	5.5	80
2.0	9.4	60
3.0	13.0	40
4.0	17.1	20
5.0	21.0	0

These series of samples were to be used as reference standards in all subsequent darkening of color scorings of the beverage product. An unknown sample could easily be measured against the series of standard samples and an appropriate quality score could then be determined.

The clarity degree of failure grades were also statistically analyzed. The analysis of variance of these subjective grades for clarity is shown in Table 4.

TABLE 4

Analysis of variance—degree of failure for clarity (Color is normal color of beveage)

Source of variation	Sum of squares	Degrees of freedom	Mean square	F ratio
Between trials	0.007	1	0.007	$F < 1$
Among judges	0.050	2	0.025	$F < 1$
Among clarity levels	93.550	5	18.71	3261.11***
Linear component	88.050	1	88.05	692.96***
Quadratic component	5.370	1	5.37	198.89***
Cubic and higher component	0.130	3	0.043	1.59NS
Pooled Residual	0.723	27	0.027	.....
Interactions:				
Judges x trials	0.005	10	0.028	$F < 1$
Judges x clarity levels	0.180	5	0.018	$F < 1$
Clarity levels x trials	0.183	10	0.037	1.19NS
Residual	0.305	35	0.031	.....
Total	94.33			

Critical Level = 1%; ***Significant at the 0.1% level; NS—Not significant. Reproducibility (P = 99.73% = ±0.48 units of failure for one measurement from any one judge, on the subjective scale.

The analysis of variance showed that the judges were grading the samples in a uniform and similar manner since there was no significant difference between the judges nor any significant interaction. The reproducibility of any one judge, based on any one measurement or trial was ±0.48 units of failure (P = 99.73%) on the subjective scale. This indicated that subjective clarity judgments could be realistically made on any one measurement to the nearest half unit of failure. The relationship between the objective (mg.) scale and the subjective (degree of failure) scale was shown to be a single inflection curve since the second degree curve (quadratic) component of the among clarity levels mean square was very highly significant while the more complex curve components were not significant.

Following the analysis of variance of the clarity levels, the mean subjective clarity grades for the three judges were plotted against the amount of colloidal material present. The plot of the data revealed an asymptotic regression curve rather than a true second degree (quadratic) curve. Patterson's method *(5)* was used in fitting this type of regression, and the equation for the curve was: Estimated Degree of Failure = 5.3233–6.0047 ($0.7320^{mg.}$). This asymptotic regression of degree of failure and the objective clarity scale is shown in Figure 2. The analysis of variance for the regression is shown in Table 5.

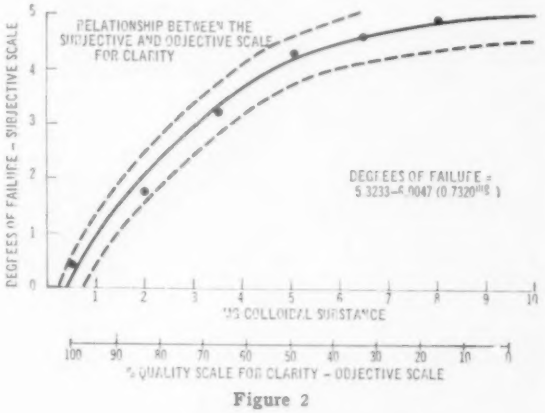
RELATIONSHIP BETWEEN THE SUBJECTIVE AND OBJECTIVE SCALE FOR CLARITY
DEGREES OF FAILURE = 5.3233–6.0047 (0.7320^mg.)
DEGREES OF FAILURE – SUBJECTIVE SCALE
mg COLLOIDAL SUBSTANCE
% QUALITY SCALE FOR CLARITY – OBJECTIVE SCALE

Figure 2

TABLE 5

Analysis of variance—regression of degrees of failure on amount of colloidal material

Source of variation	Sum of squares	Degrees of freedom	Mean square	F ratio
Due to regression	93.365	1	93.365	3590.96***
Deviations from regression	0.185	4	0.046	1.77 NS
Residual	0.780	30	0.026	
Total	94.33	35		

***Significant at the 0.1% level; NS—Not significant.

The analysis of variance of the regression indicated that the fitted curve well represented the relationship between the degree of failure grades and the amount of colloidal material present in the samples. The deviations from the asymptotic regression were not significant while the regression itself was very highly significant.

The objective quality scores for clarity of the product were determined by dividing the range covered by the regression of the samples, 0.4 mg. to 9.3 mg., inclusive, into one hundred equal parts. This per cent quality scale is shown in Figures 2 and 3. The subjective degrees of failure were converted directly into objective quality scores from these graphs. Standard samples for clarity of the beverage were prepared in accordance with the relationship between the subjective degree of failure scale and the objective scales.

These reference standards were to be used in all subsequent gradings for clarity of the beverage product having a normal beverage color. The unknown samples would then be matched against the standard samples and an objective quality score for clarity could then be assigned.

The reproducibility of the subjective degree of failure grades for both color and clarity were very similar for this judging panel: ± 0.52 units for color and ± 0.48 units for clarity. These values represent the basic capability of the panel for subjective judgments of this type. Color and clarity samples may then be graded to the nearest half unit on the subjective scale.

Referring to Figure 3, the color and the clarity curves reveal the effect of these beverage quality

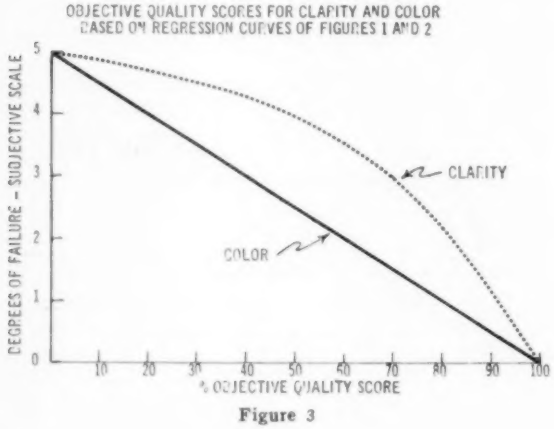
OBJECTIVE QUALITY SCORES FOR CLARITY AND COLOR
BASED ON REGRESSION CURVES OF FIGURES 1 AND 2
DEGREES OF FAILURE - SUBJECTIVE SCALE
CLARITY
COLOR
% OBJECTIVE QUALITY SCORE

Figure 3

characteristics on the subjective grades of the judging panel. The panel judged or weighted each degree of failure of color equally. The judgment factor for each degree of color is one. Some degrees of failure for clarity were considered to be more important by the panel than were others. Hence, the judgment factor for the various degrees of failure for clarity is not constant throughout the range of quality. Obviously, if the degrees of failure were equally weighted, a straight line at a 45° angle would describe the relationship between degree of failure and the objective quality scores. If the degrees of failure are not equally weighted but are weighted in a systematic manner, an asymptotic curve will result. A curve above the straight line indicates a characteristic which approaches a failure point slowly. That is, slight changes in quality levels result in small changes in degrees of failure; for this reason the degrees of failure for a quality characteristic of this type will have weights of less than one. Any product characteristic which reacts quickly to small changes in quality levels will lie below the straight line; the subjective degrees of failure, in this instance, will have weights greater than one. Consequently, from Figure 3, color was judged by the panel to be a more important quality characteristic than was clarity.

Figure 4 shows the naturally weighted color and clarity scores plotted against the values they would assume if the quality characteristic of clarity was equally weighted by the judging panel throughout the failure range. It is possible to obtain the judgment factor from this plot. The color curve obviously has

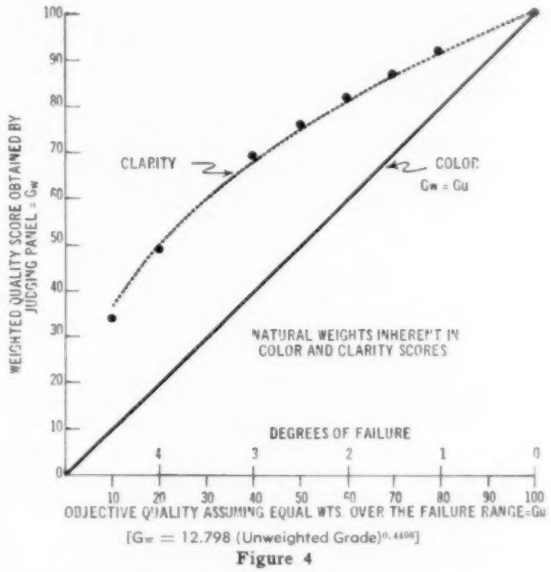
WEIGHTED QUALITY SCORE OBTAINED BY JUDGING PANEL = Gw
CLARITY
COLOR
Gw = Gu
NATURAL WEIGHTS INHERENT IN COLOR AND CLARITY SCORES
DEGREES OF FAILURE
OBJECTIVE QUALITY ASSUMING EQUAL WTS. OVER THE FAILURE RANGE=Gu
[Gw = 12.798 (Unweighted Grade)^0.4496]

Figure 4

a weight of one. A line of best fit was fitted to the clarity data and the curve was shown to be a logarithmic curve:

$$\text{Panel Clarity Grade} = 12.798 \times (\text{unweighted grade})^{0.4496}$$

Hence, the judgment factor or natural weight for clarity is a logarithmic function as evidenced by these data and has a weight of $(\text{unweighted grade})^{0.4496}$. The natural weight which is present in the objective quality scores for clarity may be characteristic of a specific judging panel. It must be emphasized, therefore, that the judgment weights shown in Figure 4 were determined from the actual grades assigned by the panel of judges and were not known in advance.

Determination of composite scores. Composite or average scores which are naturally weighted for the various quality characteristics of the product may be determined in several different ways:

(1) Simple averages of the individual quality characteristics. This method assumes that the natural weights of the individual characteristics add rather than multiply in the composite score. However, if logarithmic weights are obtained, it is not advisable to use arithmetic averages.

(2) Regression and correlation of a visual or sensory composite acceptability score with the single objective quality scores (the "Gestalt" characteristic). This method may result in a rearrangement of the natural weights of the individual characteristics in the composite score since an over-all visual acceptability impression may cancel part of the impression made by single quality characteristics. This second

method is more realistic for consumer acceptance studies than the use of a simple average quality score.

(3) Geometric average of the individual quality characteristics. When a visual or sensory composite score is difficult to obtain, this method results in a more realistic impression of consumer acceptance since if one quality characteristic has an objective quality score of zero, the product is rejected.

The above methods will be described in greater detail in a subsequent article.

SUMMARY

Subjective quality measurements have a tendency to drift or to change in meaning with time and with judges unless they are anchored to a reproducible objective scale. The relationship between the objective and the subjective scales is easily determined by statistical methods, and the precision of quality judgments is assessed by such methods. Objective quality scores can be established from the relationship between the objective and the subjective scales. These methods are illustrated, using a set of data simulating the color and clarity of a beverage product. The natural weights or judgment factors inherently present in the quality characteristic data obtained from a panel of judges may be isolated and studied.

LITERATURE CITED

1. Hopkins, J. W. A procedure for quantifying subjective appraisals of odor, flavor, and texture of foodstuffs. *Biometrics*, **6**, 1 (1950).
2. Hopkinson, R. G. Factors affecting choice and judgment. *Nature*, **171**, 31 (1940).
3. Juran, J. M. *Quality Control Handbook*. 1951. McGraw-Hill Book Company, New York, N. Y.
4. Kauman, W. G., Gottstein, J. W., and Lantican, D. Quality evaluation by numerical and subjective methods with application to dried veneer. Biometrics, **12**, 2, 127 (1956).
5. Patterson, H. D. A simple method for fitting an asymptotic regression curve. *Biometrics*, **12**, (3) 323 (1956).
6. Planck, R. P. A rational method for grading food quality. *Food Technol.*, **2**, 241 (1948).
7. Scott Blair, G. W., and Coppen, F. M. V. The subjective judgment of the elastic and plastic properties of soft bodies. *British J. of Psychology*, **31**, 61 (1940).
8. Sheppard, D. Descriptive terms and point systems for rating food quality. *Food Research*, **20**, 114 (1955).
9. Sheppard, D. Rating methods for assessing food qualities. *Food*, **22**, 256 (1953).
10. Smith, H. R. Objective measurement of quality in foods. *Food Technol.*, **1**, 345 (1947).

The Potential Application of Antibiotics in the Salmon Canning Industry

II. Chemical and Bacteriological Evaluations[a]

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(Manuscript received May 15, 1957)

THE SOCKEYE SALMON *(Oncorhynchus nerka)*, one of the most valuable species of fish found in the Western coastal waters of North America, represents a sizeable resource. The average American pack for the years 1945 through 1955 was approximately 1,750,000 standard cases, valued at $50,000,000 *(1)*. One of the major problems facing the canners of sockeye salmon is the storage of the catch prior to canning. Because of the nature of fishery operations and the regulations affecting them, the canner has to handle large quantities in very short intervals of time. He may receive as many as a million fish a day, and the total time of operation may be as short as a week or 10 days, with the maximum only a month or so. Table 1, which presents the 1956 catch statistics of sockeye salmon in the Naknek-Kvichak area of Bristol Bay, Alaska, where there were but two canneries in operation, gives an impression of the scope of the industry.

TABLE 1

1956 catch statistics of sockeye salmon in the Naknek-Kvichak area, Bristol Bay, Alaska[1]

Date	Total fishing days	Number of fish total catch
6/25–26	1.25	67,631
6/28–29	1.25	238,923
7/2 –3	1.25	298,894
7/5 –6	1.50	1,078,784
7/9 –10	1.75	1,737,771
7/12–13	1.75	1,752,819[2,3]
7/16–17	1.50	638,680[2]
7/19–20	1.25	94,479
7/23–24	1.25	65,409

[1] These data were furnished by the Bureau of Commercial Fisheries, Alaska Region, United States Fish and Wildlife Service.
[2] Catch per boat limited by canneries.
[3] Author's estimate of catch if boats were not put on limit—3,256,000 fish.

The cost of such a short time, high speed operation is often very high, particularly where men, supplies, equipment, and fuel have to be transported to relatively remote areas along the Alaskan coast. Although mechanical refrigeration is being brought into greater use as a means of holding raw fish, it is costly to install and to operate. The fishing season is usually short, and the installation of refrigeration and other heavy handling equipment often constitutes a considerable financial risk. To date, therefore, the investment in refrigeration equipment has been rather limited. A few shore installations use refrigerated brine, and some companies have started to use refrigerated brine on the barges.

It is clear that any method which will extend the storage life of the salmon and ameliorate the problems due to periods of heavy supply and acute shortage, without incurring additional heavy investment, will reduce the risk involved and also make for an improved operation.

In 1944, Tarr *(13)* reported the first work on the use of antibiotics for the preservation of fish. Since that time, this preservation technique has spread and its application to poultry, meat, and other foods *(6, 7, 8, 9)* is well known. The tetracycline group of antibiotics has been found to be particularly effective *(10, 14)* in preserving animal products. The application of these antibiotics to retard salmon spoilage prior to canning was therefore a natural outgrowth of the success of the original research. The continued interest of the canners in finding a more economic method for preserving the catch than was available to them was an equally important factor.

EXPERIMENTAL

During the summer of 1956, working in co-operation with Charles Pfizer and Company and the Alaska Packers Association at the latter's Semiahmoo Cannery (in Blaine, Washington), the present investigators conducted research to determine the effects of oxytetracycline and chlortetracycline on the retardation of spoilage of sockeye salmon.

Two studies were involved: (a) brine-holding experiments and (b) air-storage experiments after spraying with antibiotics. For the brine-storage experiments, the equipment consisted of two large wooden tanks equipped to recirculate refrigerated brine. In each of these tanks 5 wax-lined oil drums were placed. Each drum was lined with a polyethylene bag, filled with round fish, brine, and antibiotics where applicable (see Figure 1).

The conditions of brine storage were those shown in Table 2. The air-storage experiments were conducted as follows: In the first of these, salmon were sprayed with 100 p.p.m. of oxytetracycline immediately upon receipt aboard a tender at the fishing grounds and held in air ($65 \pm 5°$ F.) along with fish which had

[a] Presented at the Seventeenth Annual Meeting of the Institute of Food Technologists, May 15, 1957, Pittsburgh, Pennsylvania. Contribution No. 22, School of Fisheries, University of Washington, Seattle.

Figure 1. Equipment used for holding of salmon in refrigerated brines.

been sprayed with sea water. In the second, fish were given a spray of 20 p.p.m. oxytetracycline on two successive days. Controls in the latter case were sprayed with sea water under the same conditions.

TABLE 2

Summary of storage conditions for brine holding experiments

Brine temperature		
32° F.	40° F.	50° F.
5 p.p.m. OTC	5 p.p.m. OTC	5 p.p.m. OTC
10 p.p.m. OTC	10 p.p.m. OTC	10 p.p.m. OTC
20 p.p.m. OTC	20 p.p.m. OTC	20 p.p.m. OTC
5 p.p.m. CTC	10 p.p.m. CTC	20 p.p.m. CTC
Control (No Antibiotic)	Control	Control

OTC = Oxytetracycline.
CTC = Chlortetracycline.

For each experimental condition, a sample of 4 fish was removed from each batch after specific intervals of storage. Single steaks from each of the fish were ground together, canned, frozen, and held for chemical and bacteriological analyses. The remaining steaks were canned in the standard cannery manner and held for organoleptic and chemical testing.

The organoleptic tests were conducted by two separate groups. The first examination took place at the School of Fisheries, University of Washington, Seattle, the panel consisting of individuals from the salmon canning industry. The details of the examination have been presented in a previous paper *(10)*. The second examination, in San Francisco, was undertaken jointly by the California Packing Corporation and the personnel of the Fisheries Research Laboratory, Hooper Foundation, University of California. A summary of the results of these examinations is presented in Table 3.

Chemical tests on the raw frozen samples consisted of volatile acids and volatile bases determinations using the vacuum distillation technique *(15)*. The results of these tests are presented in Tables 7–11. The chemical determinations performed on the canned samples of fish were those for (a) volatile reducing substances *(4)*, and (b) for total volatile nitrogen and trimethylamine nitrogen determinations, using the microdiffusion technique *(2)*. In addition, the volatile acids and volatile bases determinations were carried out on the canned samples from fish which had been maintained in 32° F. brines. The results of these determinations are also presented in Tables 7–11.

The direct microscopic count and the standard plate count techniques *(13)* were attempted for the bacteriological examination of the frozen samples.

RESULTS AND DISCUSSION

Under the conditions of this investigation, the antibiotics extended the overall storage life of the sockeye salmon and also, for a short time, the period when the salmon were judged as good. This is demonstrated by Table 3 which summarizes the organoleptic judgments of the heat processed samples. As the table shows, the judgments obtained in the Seattle and San Francisco tests were markedly similar. The table also demonstrates that there were no apparent differences in the effect of the two antibiotics, oxytetracycline and chlortetracycline, used in the brine experiments. All the levels of the antibiotics used in these experiments seemed equally effective, indicating that brine containing 5 p.p.m. of either antibiotic is of sufficient concentration to give the maximum preservative effect. In the case of the sprays, however, the 100

TABLE 3

Summary of brine storage and spray experiments based on organoleptic judgments of canned samples

Storage condition	Concentration of antibiotic	Days rated good		Days until rated poor	
		Seattle	San Francisco	Seattle	San Francisco
32° F. Brine	Control	12	10	15	13
	5 p.p.m. OTC	15	14	24	22
	10 p.p.m. OTC	15	13	24	23
	20 p.p.m. OTC	15	13	27	22
	5 p.p.m. CTC	15	12	24	20
40° F. Brine	Control	2	3	3	5
	5 p.p.m. OTC	3	4	5	8
	10 p.p.m. OTC	5	5	7	8
	20 p.p.m. OTC	5	4	7	7
	10 p.p.m. CTC	5	4	7	6
50° F. Brine	Control	2	2	3	3
	5 p.p.m. OTC	3	2	4	4
	10 p.p.m. OTC	3	3	4	4
	20 p.p.m. OTC	3	3	4	4
	20 p.p.m. CTC	3	2	4	4
Room-Temp. Spray	Control	2	1	2	2
	100 p.p.m. OTC	3	2	3	3
	Control	1	1	2	2
	1 spray—20 p.p.m. OTC	2	1	2	2
	2 sprays—20 p.p.m. OTC	2	1	3	2

p.p.m. spray was more effective than was the 20 p.p.m. spray. Results with two 20 p.p.m. sprays were doubtful. According to the Seattle examination, two 20 p.p.m. applications equaled the effects of the single 100 p.p.m. spray treatment. The result was not borne out by the San Francisco examination.

Texture changes were not noted in the canned fish at either of the examinations until the fish were well past the limit of acceptability; even then the changes were not consistent. In some instances, the samples were rated *poor*, owing to rancid or off-odors that were thought to be nonbacterial in origin. It appears, therefore, that changes in the flesh and fat of salmon can occur as a result of autolytic and chemical processes as well as from the activities of microbial life, possibly other than bacterial.

The retardation of spoilage was inconclusive on the basis of the results of the bacteriological determinations. It was necessary to freeze and store the samples in the frozen state prior to determining the bacterial counts. It was hoped that the use of the direct microscopic count technique would obviate the effects of freezing. However, attempts to apply this technique were unsuccessful and viable plate counts were used. It appears that there was considerable destruction of the organisms due to freezing and frozen storage since counts on the most spoiled fish rarely reached the level of 10^6 organisms per gram. Table 4 gives representative data on the plate counts.

It is believed that the destruction due to freezing was selective, eliminating the more sensitive organisms and leaving the resistant or conditioned organisms which one might expect to find in the bacteriostatic environment of the antibiotic solutions. The application of differential staining *(5)* demonstrated that a larger number of spores were present in the fish stored in antibiotic brines than in the controls. Furthermore, when samples from the 32° F. brine-storage experiment were incubated for 24 hours at 50° F. prior to counting, the control samples were higher in count than those samples from fish treated with the antibiotics. This indicates that the antibiotics had either inhibited or were inhibiting bacterial growth in the treated fish. The results are presented in Table 5.

In the case of the spray treated fish, the bacterial plate counts demonstrated lower counts in the treated fish than in the controls (Table 6). It is possible that under the conditions of warm air storage (65 ± 5° F.),

TABLE 4

Plate counts (org./g.) of raw frozen salmon previously stored at 32° F. in refrigerated brines containing various concentrations of oxytetracycline and chlortetracycline[1]

Days in brine	Control (no antibiotic added)	Concentrations of antibiotics			
		5 p.p.m. Oxytetracycline	10 p.p.m. Oxytetracycline	20 p.p.m. Oxytetracycline	5 p.p.m. Chlortetracycline
3	200	400	4,800	2,100	1,400
6	1,100	.....	.....	.....	.....
9	.....	700	700	1,100	700
12	400	600	900	1,700	1,200
15	600	900	1,500	700	800
18	1,300	1,000	1,300	2,700	1,700
21	1,200	17,000	8,600	6,800	12,000

[1] Tryptone glucose extract agar plates incubated at 17–19° C. for 48 hours.

TABLE 5

Plate counts of raw frozen salmon previously stored at 32° F. in refrigerated brines, frozen, then incubated prior to plating

Sample treatment: Removed from frozen storage and incubated at 17–19° C. prior to plating with Tryptone Glucose Extract Agar (3% salt added to medium). Plates incubated at 17–19° C. for 48 hours.

Days in brine	Control (org./g.) (No antibiotic added to brine)	5 p.p.m. Oxytetracycline added to brine (org./g.)
6	540,000	370,000
9	2,800,000	910,000
12	.....	870,000
15	8,000,000	1,200,000
18	6,000,000	21,000,000

TABLE 6

Plate counts (org./g.) for raw frozen salmon previously stored at air temperature (65 ± 5° F.) and sprayed with 20 p.p.m. oxytetracycline[1]

Days	20 p.p.m. OTC spray			100 p.p.m. OTC spray	
	Control Sea water spray	Single spray 1st day	2nd spray on 2nd day	Control Sea water spray	Spray
1	13,000	19,000	.....	5,000	1,400
2	44,000	38,000	34,000	82,000	.....
3	640,000	130,000	120,000	420,000	47,000
4	.....	.....	.....	.....	87,000
5	.....	.....	.....	.....	450,000

[1] Culture Medium: Tryptone Glucose Extract Agar w/3% NaCl added to dilution blanks. Plates were incubated at 17–19° C. for 48 hours.

TABLE 7

Chemical determinations of frozen raw sockeye salmon stored at 32° F. prior to canning in brines with and without antibiotics

Time of storage	Control (No antibiotic)		5 p.p.m. OTC		10 p.p.m. OTC		20 p.p.m. OTC		5 p.p.m. CTC	
(Days)	V.A.[1]	V.B.[2]	V.A.	V.B.	V.A.	V.B.	V.A.	V.B.	V.A.	V.B.
3	40.5	11.8	40.3	12.3	44.0	11.7	37.1	11.4	36.5	11.1
6	39.0	11.2	.....	.....	.....	.....	.....	.....	.....	.....
9	.....	.....	34.9	12.4	35.1	11.3	33.8	9.3	34.0	10.2
12	31.9	10.5	32.1	12.5	36.3	11.1	34.6	8.9	34.0	9.5
15	51.1	11.8	43.9	16.2	35.3	10.3	37.4	9.4	38.0	10.4
18	53.4	12.6	40.5	14.4	45.7	12.9	39.4	12.6	37.8	11.0
21	57.4	12.7	.....	.....	.....	.....	.....	.....	.....	.....
24	.....	.....	.....	.....	38.9	12.7	46.7	11.5	38.2	10.6
27	.....	.....	44.2	13.3	.....	.....	.....	.....	.....	.....

[1] V.A.: Volatile acids—ml. 0.01 N acid per 100 g.
[2] V.B.: Volatile bases—mg. N per 100 g.

TABLE 8

Chemical determinations of canned sockeye salmon stored at 32° F. prior to canning in brines with and without antibiotics

Time of storage (Days)	Control (No antibiotic)					5 p.p.m. OTC					10 p.p.m. OTC					20 p.p.m. OTC					5 p.p.m. CTC				
	V.A.	V.B.	V.R.S.[1]	T.V.N.[2]	T.M.N[3]	V.A.	V.B.	V.R.S.	T.V.N.	T.M.N.	V.A.	V.B.	V.R.S.	T.V.N.	T.M.N.	V.A.	V.B.	V.R.S.	T.V.N.	T.M.N.	V.A.	V.B.	V.R.S.	T.V.N.	T.M.N.
0	.....	.....	11.2	39.9	6.9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
3	44.8	39.1	8.2	39.5	7.5	44.9	35.7	10.3	41.5	7.3	50.8	36.9	8.0	46.3	6.6	42.4	34.2	8.6	39.5	5.8	42.1	38.1	8.6	37.4	6.0
6	.....	.....	7.6	35.8	6.0	.....	.....	8.3	39.4	7.3	.....	.....	7.9	39.1	9.1	.....	.....	6.2	41.0	7.3	.....	.....	6.4	37.9	3.3
9	39.0	33.3	12.9	34.9	3.8	43.4	34.8	8.9	34.0	4.4	43.6	36.7	7.5	35.9	6.4	42.8	33.7	15.2	38.6	5.3	40.7	31.1	7.4	37.2	3.7
12	.....	.....	21.1	35.3	5.8	.....	.....	8.0	38.9	4.6	.....	.....	8.7	39.9	4.9	.....	.....	12.2	35.9	3.9	.....	.....	12.9	33.8	3.7
15	59.0	30.2	37.9	37.9	5.6	53.2	32.0	14.8	36.2	5.6	55.1	32.5	13.6	38.5	3.7	44.5	31.7	19.4	32.3	4.3	59.0	34.4	13.7	35.2	4.7
18	.....	.....	40.5	37.2	3.3	.....	.....	18.1	34.7	10.2	.....	.....	20.0	35.2	3.5	.....	.....	17.9	38.7	3.5	.....	.....	21.4	36.4	8.5
21	73.3	37.1	41.5	37.2	4.0	55.2	34.2	14.2	41.8	7.3	52.7	36.7	24.6	37.0	7.0	50.5	35.0	25.9	34.7	3.4	63.6	39.0	32.5	38.6	4.8
24	.....	.....	.....	.....	.....	.....	.....	24.7	41.3	6.4	.....	.....	16.7	41.2	6.2	.....	.....	9.1	37.1	3.5	.....	.....	19.1	38.3	4.6
27	.....	.....	.....	.....	.....	.....	.....	19.7	39.7	7.4	.....	.....	24.4	36.0	6.6	.....	.....	16.7	37.7	3.7	.....	.....	22.3	34.1	3.9

[1] V.R.S.: Volatile reducing substances—microequivalents per 5 ml. press juice.
[2] T.V.N.: Total volatile nitrogen—mg. N per 100 ml. press juice.
[3] T.M.N.: Trimethylamine nitrogen—mg. N per 100 ml. press juice.

TABLE 9

Chemical determinations of frozen raw and canned sockeye salmon stored prior to canning at 40° F. in brines with and without antibiotics

Time of Storage (Days)	Control (No antibiotics)			5 p.p.m. OTC			10 p.p.m. OTC			20 p.p.m. OTC			10 p.p.m. CTC		
	Raw		Heat processed	Raw		Heat processed	Raw		Heat processed	Raw		Heat processed	Raw		Heat processed
	V.A.	V.B.	V.R.S.	V.A.	V.B.	V.R.S.	V.A.	V.B.	V.R.S.	V.A.	V.B.	V.R.S.	V.A.	V.B.	V.R.S.
1	37.4	10.6	14.7	23.8	12.6	16.1	29.8	12.4	12.6	38.0	12.0	14.5	36.7	12.8	6.7
2	34.2	10.8	12.2	.....	.....	8.3	.....	.....	15.1	.....	.....	10.6	.....	.....	14.0
3	38.4	11.6	15.3	18.4	12.4	11.5	32.6	12.0	20.3	36.1	11.4	23.5	33.6	10.5	15.0
5	.....	16.8	31.5	26.1	11.9	13.3	34.5	12.4	12.2	33.4	11.0	16.8	34.6	11.2	17.6
7	72.4	18.1	41.2	35.9	17.3	23.4	61.4	18.0	34.7	43.0	13.8	23.5	39.4	13.6	39.5
9	105.4	.....	44.8	85.4	17.4	38.2	57.4	14.1	42.2	90.6	17.8	44.8	83.3	14.9	51.6
11	.....	.....	.....	.....	.....	37.5	.....	.....	55.4	.....	.....	48.3	.....	.....	31.9
13	.....	.....	.....	88.7	20.5	61.2	99.6	16.9	48.8	82.6	18.4	46.7	135.1	19.4	56.9

TABLE 10

Chemical determinations of frozen raw and canned sockeye salmon stored at 50° F. prior to canning in brine with and without antibiotics

Time of storage (Days)	Control (No antibiotics)					5 p.p.m. OTC					10 p.p.m. OTC					20 p.p.m. OTC					20 p.p.m. CTC				
	Raw		Heat processed			Raw		Heat processed			Raw		Heat processed			Raw		Heat processed			Raw		Heat processed		
	V.A.	V.B.	V.R.S.	T.V.N.	T.M.N.	V.A.	V.B.	V.R.S.	T.V.N.	T.M.N.	V.A.	V.B.	V.R.S.	T.V.N.	T.M.N.	V.A.	V.B.	V.R.S.	T.V.N.	T.M.N.	V.A.	V.B.	V.R.S.	T.V.N.	T.M.N.
0	.....	.....	8.2	40.6	7.3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1	41.4	13.0	8.4	43.2	10.6	31.9	13.1	4.6	5.1	10.4	30.0	12.5	2.6	43.3	8.9	30.1	13.5	11.4	44.0	11.0	25.7	13.3	9.0	43.1	5.8
2	37.6	12.5	2.7	44.5	7.9	30.5	12.9	3.9	41.6	6.8	34.9	12.9	19.5	44.6	4.1	39.0	12.2	9.8	43.0	9.2	35.5	13.0	7.5	42.9	6.9
3	49.7	12.8	13.7	40.1	9.1	29.4	12.7	10.2	41.0	10.2	38.2	12.8	15.5	42.8	9.4	40.1	12.4	15.3	43.5	10.0	38.0	11.9	6.6	42.7	6.0
4	67.7	21.9	39.9	43.7	10.1	35.5	17.9	25.9	42.7	7.8	49.5	17.3	27.6	41.0	6.4	48.9	16.0	21.7	44.1	4.8	48.9	18.0	21.1	41.5	9.0
5	96.4	23.6	45.7	43.3	7.5	61.6	19.9	44.5	42.5	5.6	87.3	20.0	46.4	39.2	8.1	69.1	18.7	44.4	42.8	9.6	72.1	22.7	44.9	40.6	9.0
6	.....	.....	.....	.....	.....	110.6	22.2	46.6	40.5	5.6	116.2	22.1	48.9	43.1	12.9	102.0	20.5	46.5	38.7	38.7	99.0	20.8	36.7	42.6	7.9

TABLE 11

Chemical determinations of frozen and canned Sockeye salmon sprayed with antibiotics and stored in air (65 ± 5° F.) prior to canning

First experiment

Time of storage (Days)	Control			100 p.p.m. OTC spray		
	Raw		Heat processed	Raw		Heat processed
	V.A.	V.B.	V.R.S.	V.A.	V.B.	V.R.S.
1	31.7	15.9	15.3	34.4	14.8	11.9
2	37.8	17.7	15.0	.....	.....	10.8
3	62.7	24.4	36.2	47.0	22.0	17.9
4	.....	.....	.....	79.9	28.5	25.8
5	.....	.....	.....	134.9	35.1	55.0

Second experiment

Time of storage (Days)	Control			One spray 20 p.p.m. OTC			Two sprays 20 p.p.m. OTC		
	Raw		Heat processed	Raw		Heat processed	Raw		Heat processed
	V.A.	V.B.	V.R.S.	V.A.	V.B.	V.R.S.	V.A.	V.B.	V.R.S.
1	36.3	14.3	13.8	41.1	14.5	16.4	.....	.....	.....
2	56.5	19.1	16.3	41.9	15.8	13.8	42.6	16.6	15.5
3	150.0	31.5	46.8	57.2	21.7	35.3	58.9	21.5	38.0
4	.....	.....	.....	.....	.....	.....	.....	.....	.....
5	.....	.....	.....	.....	.....	.....	.....	.....	.....

the bacteria in all cases were multiplying rapidly with minimal inhibition resulting from the presence of the antibiotic. Consequently, when the samples were frozen, these young cells were destroyed in equal proportion for both the antibiotic-treated and the control samples, as opposed to the possible selectivity in the brine-stored samples.

The chemical results shown in Tables 7–11 indicate the same general pattern as the organoleptic judgments. In the case of the raw frozen fish held in brine, the volatile acids and volatile bases determinations indicate that slight, if any, difference existed between the two antibiotics or in the effects of the various levels that were used. The results similarly demonstrated the prolongation of storage life that resulted from the use of the antibiotics as noted in the organoleptic judgments. For the raw frozen fish, the volatile acids determinations correlated better than the volatile bases with the organoleptic judgments. This is shown in Table 12.

TABLE 12

Statistical analyses of spoilages indices vs. organoleptic results

Volatile acids

	Organoleptic score			
V.A.	1	2	3	4
Mean	35.50	44.72	76.28	108
S. D.[1]	5.03	8.10	23.79	19.6
S. E.m[2]	0.6845	1.811	5.07	7.40
N	54	20	22	7

Volatile bases

	Organoleptic score			
V.B.	1	2	3	4
Mean	12.31	14.75	19.16	19.92
S. D.[1]	2.296	3.34	5.28	2.60
S. E.m[2]	0.3124	0.747	1.113	0.981
N	54	20	22	7

[1] S. D. = Standard Deviation.

[2] S. E.m = Standard error of mean.

For the canned fish, the volatile reducing substances followed the organoleptic judgments more closely than the total volatile nitrogen or trimethylamine nitrogen determinations which appear to be of little value. In the case of the 32° F. brine storage experiment, the volatile acids and bases tests were run on the canned samples as well as the volatile reducing substances test. In this case, the volatile reducing substances test appeared to be more indicative of spoilage than the other two. Similar to the results for the raw fish, the chemical examinations of the canned samples demonstrated a longer storage life prior to canning for the antibiotic-treated fish. Here again, there were no differences apparent either between the various levels of the antibiotics or between the two antibiotics.

The chemical results as well as the results of the organoleptic examinations indicate that the extension of the storage time beyond that of the control is dependent upon the storage temperature. The lower the temperature, the longer in absolute time is the extension of the storage period.

It should be noted that assays for residual antibiotic activity in the canned products were negative.

SUMMARY

Under the conditions of this investigation, oxytetracycline and chlortetracycline retarded the spoilage of sockeye salmon. The overall storage life appeared to be extended by a factor of approximately 1.5 over the cases where no antibiotics were used.

The extension of the storage time was dependent on the temperature. At the high storage temperatures (65 ± 5° F.), the absolute time of extension was relatively small, while at 32° F., the absolute time of extension was considerable.

The chemical and organoleptic examinations substantiated the above conclusions. The results of the bacterial examination were inconclusive probably due

to the fact that the samp' s were stored at freezing temperatures prior to examination.

Assays for residual antibiotic activity in the canned product were negative.

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LITERATURE CITED

1. Anonymous. *Pacific Fisherman*, **54** (2) 83 (1956).
2. Conway, E. J. *Micro-Diffusion Analysis and Volumetric Error*. Rev. ed., 1947. D. Van Nostrand Company, Inc., New York.
3. Farber, L. Antibiotics as aids in fish preservation. I. Studies in fish fillets and shrimp. *Food Technol.*, **8**, 503 (1954).
4. Farber, L., and Ferro, M. Volatile reducing substances (VRS) and volatile nitrogen compounds in relation to spoilage in canned fish. *Food Technol.*, **10**, 303 (1956).
5. Frobisher, M., Jr. *Fundamentals of Bacteriology*. 1950. W. B. Saunders Company, Philadelphia.
6. Godkin, W. J., and Cathcart, W. H. Effect of antibiotics in retarding the growth of *micrococcus pyogenes* var. *aureus* in custard fillings. *Food Technol.*, **6**, 224 (1953).
7. Goldberg, H. S., Weiser, H. H., and Deatherage, F. E. Studies on meat. IV. Use of antibiotics in the preservation of fresh beef. *Food Technol.*, **7**, 256 (1953).
8. Inomoto, Y., and Hashida, W. Application of antibiotics to the food industry. I. Preservation of cow milk. *J. Fermentation Technol., Japan*, **30**, 287 (1952).
9. Kohler, A. R., Miller, W. H., and Broquist, H. P. Aureomycin, chlortetracycline and the control of poultry spoilage. *Food Technol.*, **9**, 151 (1955).
10. Lerke, P. A., and Farber, L. Prolongation of the keeping quality of fish and shellfish by antibiotics. *Antibiotics Annual, 1956–1957*, 966 (1957), Med. Encyclopedia, Inc., New York, N. Y.
11. Stern, J. A., Liebman, H. L., Munkelt, R. E., and Hatherell, B. The potential application of antibiotics in the salmon canning industry. I. Organoleptic evaluations. *Antibiotics Annual, 1956–1957*, 975 (1957). Med. Encyclopedia, Inc., New York, N. Y.
12. Tarr, H. L. A. Rise and fall of bacterial populations in fish muscle. *J. Fish. Res. Bd. Canada*, **6**, 119 (1943).
13. Tarr, H. L. A. Chemical inhibition of growth of fish bacteria. *J. Fish. Res. Bd. Canada*, **6**, 257 (1944).
14. Tarr, H. L. A., Southcott, B. A., and Bissett, H. M. Effect of several antibiotics and food preservatives affecting the spoilage of fish. *Fish. Res. Bd. Canada, Progress Reports, Pacific Coast Stations*, **83**, 35 (1950).
15. Tomiyama, T., da Costa, A. A., and Stern, J. A. A rapid distillation procedure for the determination of volatile acids and volatile bases in fish flesh. *Food Technol.*, **10**, 614 (1956).

Role of State Sanitary Commissions in Waste Control*

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Neither an industrial nor an agricultural economy can continue indefinitely to grow without controlling stream pollution. Other measures are necessary, also, including control of soil erosion and the construction and careful use of dams for low-flow augmentation. Such conservation measures, coupled with the control of pollution, represent the most that can be done with our present knowledge to secure the fullest use of available water supplies. Desalting of sea water may some day prove practical and actually may enlarge the amount of usable water in the world. Until then, at least, pollution control is essential to assist in guarding domestic as well as industrial supplies of water.

Industrial expansion in California, for example, is seriously affected already by the difficulty of obtaining adequate supplies of clean and usable water. In England, wells near the sea are becoming increasingly brackish because of the lowering of the ground-water level by heavy industrial and other demands and the consequent increasing penetration of sea water. Even New York City was in difficulties because of a water shortage several years ago. Effective control of pollution would make huge quantities of water available within the borders of New York State and the same holds true for other areas.

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Typical polluting effects of industrial, agricultural and other wastes. Wastes from industrial plants and farms can affect the public waters in many adverse ways. Metallurgical wastes may carry acids, toxic substances such as cyanides or chromium and copper salts, compounds like iron oxide which forms rusty coatings on the stones of a stream bed or calcium or magnesium sulphates which increase the hardness of the water. By-product coke wastes usually contain taste- and odor-producing phenols. Colliery wastes, sand washery wastes and soil erosion may transport quantities of inert material into a stream, blanketing the bottom and smothering the plants and minute animals which supply fish food; petroleum refinery wastes may carry injurious substances dissolved in the water, and oil which, floating on the surface, may reduce the absorption of oxygen from the air or foul boats, shipping gear, and stream banks.

Wastes from almost all water-using industries except those just mentioned come from the raising and processing of agricultural products; hence, in addition to mud, lime, carbon particles, etc., wastes carry decayable or unstable substances. Included would be: juices and particles of vegetables or fruit from canneries; ensilage juice; barnyard seepage from farms; and grease and blood from abattoirs. In addition, there are: cellulose fiber and spent sulphite liquor from paper and pulp mills; spent tan liquor and particles of hide, hair, dirt and lime from tanneries; milk solids in wash waters from milk plants plus whey or skim milk if spills occur; textile fibers, dye, grease, sugars etc. from textile mills; and numerous other wastes including those from pharmaceutical manufacture and, increasingly, radioactive wastes. Incidentally, an astonishing number of those responsible for pollution are not aware that solid particles are only one form of pollution and that material dissolved in waste waters often is more harmful than the solid particles.

Development of laws for the control of stream pollution. Over 50 years ago in Pennsylvania an attempt to control stream pollution by law was embodied in an act known as the *Purity of Waters Act of 1905*. This act exempted industrial wastes from its provisions by definition. In spite of this, beginnings in the control of industrial wastes discharges, chiefly by persuasion and agreement, were made soon after the end of the first world war. Working committees for the abatement of stream pollution and the collection of data for industrial wastes treatment were organized between several state pollution-control agencies and the manufactured gas, the pulp and paper, and the tanning industries. Some of these accomplished much in the way of concrete results; others did not. They all contributed to the ultimate solution of their problems. In addition, the petroleum refining, canning, and textile industries organized investigator groups of their own, keeping the various state divisions of sanitary engineering informed of their progress. Publications of the American Petroleum Institute represent an outstanding contribution toward the development of means for abating wastes from that industry. (Accomplishment may lag behind knowledge here as elsewhere.) The textile industry, through the Textile Foundation and other agencies, published useful data; the National Canners Association and certain other industries (e.g., the metallurgical) began to do the same.

During the past decade an increasing percentage of people in this country, in addition to fishermen and including a considerable number of industrialists, have come to realize that control of stream pollution is necessary in order to conserve and protect water resources for all sorts of uses besides fishing or other recreation. The effectiveness of state laws for the control of pollution is steadily growing. A poll of all the states in this country early this year showed that all except two have laws for that purpose—some not very effective as yet, to be sure, but laws nevertheless. For no matter how desirable voluntary cooperation may be, laws seem to be necessary because of those who do not "play ball."

Summary of administrative agencies. Of the 46 states which have laws concerning pollution, the designated administrative agencies fall into the following groups (Table 1).

TABLE 1

Administrative agencies concerned with pollution: the national picture

Agency	Number of states	Names
Commissions	13	Alabama, Arkansas, Delaware, Kentucky, Louisiana, Maine, Michigan, Mississippi, New Hampshire, North Dakota, Texas, Washington, West Virginia.
Boards	11	California, Illinois, Indiana, Maryland, New York, Ohio, Pennsylvania, Tennessee, Utah, Vermont, Virginia.
Authorities	2	Oregon, South Carolina.
Councils	1	Wyoming.
Committees	2	North Carolina, Wisconsin.
Sanitary Engineering Bureaus	10	Connecticut, Florida, Idaho, Iowa, Massachusetts, Nevada, Oklahoma, Rhode Island, South Dakota, Montana.
Environmental Sanitation Divisions	5	Colorado, Kansas, Minnesota, Nebraska, New Jersey.
Health Departments	2	Missouri, New Mexico.
None, but Departments of Health of both states have powers and programs.	2	Arizona, Georgia.
Total	48	

The 48 states, as may be expected, have diverse methods of handling the control of stream pollution. Letters have been sent to each state and, on the basis of the replies and certain other data, I have prepared tables covering a number of the more important functions of the pollution control agencies. These tabulations have been grouped according to the type of agency in charge of pollution control, as—commissions, boards, authorities, departments of health, etc.

TABLE 2

Functions of state pollution control agencies

	(1) Classify Streams	(2) Require a Minimum of Primary Treatment for Industrial Wastes	(3) Effluent Standards	(4) Exemptions	(5) Permits	(6) Legal Penalties	Remarks: Y = Yes, N = No
COMMISSIONS							
Alabama	Yes	No	No	No	Yes	Yes*	* Any person found guilty of violation "shall be deemed guilty of a misdemeanor."
Arkansas	N**	N*	N	N	Y	Y	* Primary tr. recommended for new plants, deferred if dilution is ample. ** But law authorizes classification.
Connecticut	Y	N	N	N	Y	Y	
Delaware	Y	N	N	N	Y*	Y	* Req. submission of plans.
Kentucky	N	Y	N	N	Y	Y	
Louisiana	N	N	N	N	N	Y	
Maine	Y	N	N	N	Y	Y	
Michigan	N	N	Y	N	Y	Y	
Mississippi	Y	Y	Y	Y*	Y	Y	* Discharges to Mississippi River exempt; law provides tax exemption for industries installing pollution control facilities.
New Hampshire	Y	N	N	N	Y	Y	
North Dakota	N	N	N	N	Y	N	
Texas	N*	Y	N**	Y***	Y	Y	* By court pronouncement, all streams Class A. ** No set standards but law req. that quality of receiving water shall not be degraded by wastes. *** Law applies only to effluents containing putrefactive organic materials, toxic compounds, or bacteria dangerous to public health or fish life.
Washington	N	N	Y	N	Y	Y	
West Virginia	Y*	N	N	Y**	Y	Y	* Stream zoned, based on quality of water. ** Wastes from coal mining.
Maryland	Y	Y	Y	N	Y	Y	
BOARDS							
California	N	N*	Y	N	N**	Y	** Approval of new plans not required; Board can prescribe eff. and stream requirements. * Case by case study of individual pollution problems.
Illinois	N	N	N	Y*	Y	Y	* Chicago San. Dist. is exempt from State Req.
Indiana	N	N	Y*	N	Y	Y	* And specified minimum standards of stream quality must be maintained.
New York	Y	N*	N**	N***	Y	Y	* Standards for most classes of water will require primary treatment. ** Stream standard will determine degree of treatment. *** Extensions of time given—financial inability, or method of treatment unknown.
Ohio	Y	Y	N	Y*	Y	Y	* Acid and silt drainage from mines, until the Board after hearing shall determine practical treatment known.
Pennsylvania	Y	Y	Y	Y*	Y**	Y	* Acid drainage from coal mines, until the Board shall determine that practical treatment is known. ** Req. submission of prof. engrs. report and plans for proposed waste treatment works.
Tennessee	N	N*	N	N	Y	Y	* Does not apply to wastes which carry no floating or settleable solids.
Utah	N	N	N	N	N	N	
Vermont	Y	N	N	N	Y	Y	
Virginia	N	N	N	N	Y	Y	
AUTHORITIES							
Oregon	Y	N	Y	N	Y	Y	
South Carolina	N	N	N	N	Y	Y	
COUNCILS							
Wyoming	N	N	N	N	Y	Y	
AGENCIES							
Idaho*	N	N	N	N	N*	N*	* Law provides for protection of State waters from effects of dredge mining, by permits and penalties through Board of Land Commissioners.
COMMITTEES							
North Carolina	N	N	N	N	Y*	Y*	* Where public water supply is involved.
Wisconsin	N	Y	Y	N	Y	Y	
SANITARY ENGINEERING BUREAUS							
Florida	N	N	N	N	Y	Y	
Iowa	N	Y	Y	Y*	Y	Y	* Border streams are exempted from procedures whereby orders may be issued requiring treatment but not from requirements of permits.
Massachusetts	Y	N	N	N	Y	Y	
Nevada	Y	N	N	N	N*	Y	* New treating-plant approval is required if the formation of a sanitary district is involved.
Oklahoma	N*	Y	Y	N	Y	Y	* Present studies will provide data that can be used to set up classification if favorable legislation is passed.
Rhode Island	Y	N	—	N	Y	Y	
South Dakota	Y	N	N	N	Y	N	
Montana	N	N	N	N	Y	Y	
ENVIRONMENTAL SANITATION BUREAUS							
Colorado	N	N	N	Y*	N	Y	* Denver water supply protected by special law under City Authority but state has jurisdiction over pollution of these waters, covers wastes from petroleum production.
Kansas	N	N	N*	N	Y	Y	* Means shall be provided to prevent the escape of salt water, oil or refuse from oil or gas wells.
Minnesota	Y	Y	N	N	Y	Y	
Nebraska	N	N	N	N	Y	Y	
New Jersey	Y	Y	Y	N	Y	Y	
DEPARTMENTS OF HEALTH							
Missouri	N	N	N	N	Y	Y	
New Mexico	N	N	N	N	Y	Y	
Arizona*	N	N	N	N	Y	Y	* Arizona has no anti-pollution law but Dept. of Health has power to enforce special orders for protection of the public health against pollution by sewage or industrial wastes.
Georgia	N*	Y**	Y	N	Y	—	* Georgia has no specific pollution statute, but a long-established program of control by a Division of the Department of Public Health. All streams intended to be maintained for their highest uses. ** Primary treatment required in most cases.
AVERAGES OF ALL POLLUTION CONTROL AGENCIES							
SUMMARY	29 No 60%	19 Yes 40%	36 No 75%	12 Yes 25%	34 No 72%	13 Yes 28%	40 No 83%	8 Yes 17%	6 No 12%	42 Yes 88%	4 No 9%	43 Yes 91%	

By means of a "yes" or "no" entry, it has been possible to indicate quickly whether a given agency classifies the streams of its state, or requires at least primary treatment for industrial waste, or has effluent standards or any exemptions, issues permits for waste treatment works, or has legal penalties—with notations where special cases occur. These tabulations are presented in Table 2.

To summarize the methods used in this country, the percentages of those which fall in the "Yes" and "No" groups in each of the functions tabulated, have been determined. For the country as a whole, 40% of state agencies classify streams; 25% require primary treatment; 28% have effluent standards; 17% make certain exemptions (as for example, acid coal mine drainage in Pennsylvania); 88% issue permits for treatment works and/or discharge; and 91% provide legal penalties for non-compliance.

THE REQUIREMENTS IN REVIEW

Some of the requirements of the pollution control agencies of several states are herewith reviewed—just by way of illustration. The variation in detail is far too great, however, for anything like a full report on every state.

Maryland. The Water Pollution Control Commission of Maryland has set up regulations which include the requirements that no industrial wastes shall be discharged into any of the waters of the state unless the solids can pass Tyler designation 20-mesh screen without grinding, maceration, or equivalent and unless the turbidity is low enough to transmit 10% of the light through 12 inches of the sample in a 3-inch column, or not to exceed 300 p.p.m. by the Jackson Candle Turbidimeter. The B.O.D. must not exceed 100 p.p.m.; toxic compounds and floating matter must be removed or reduced to limits of tolerance; oils and greases must not exceed 30 p.p.m. Color intensity regardless of light frequency must not exceed 400 p.p.m. on the chloroplatinate scale; dissolved solids must not exceed 1500 p.p.m. nor the total solids, 1900 p.p.m.; the pH must lie between 5.5 and 8.5, and the effluent must not have a threshold odor greater than 1000, while after mixture with receiving waters the threshold odor shall not exceed 80. Maryland also has established minimum stream quality standards; classifies streams, requires at least primary treatment, issues permits, and applies legal penalties for violations.

Michigan. The Michigan Stream Control Commission has not classified streams; does not require minimum treatment, but does issue permits and apply penalties for violations and gives no exemptions. To date the Michigan Commission has not adopted formal effluent standards, but has applied effluent restrictions in particular instances. An example is the order, effective since 1939 and 1940 for beet sugar wastes, which expressly prohibits the discharge of the most injurious wastes, those from the "Steffens Process," and limits the B.O.D. of all other such wastes to 5 pounds per ton of beets processed.

Connecticut. The Connecticut State Water Commission classifies streams; has no minimum treatment nor any exemptions; does issue permits and applies legal penalties, but has not adopted formal standards for industrial waste effluents, although the Commission has set them for individual plants. The requirements for wastes from electroplating may cover pH, suspended solids, turbidity, cyanides and metals in solution. Those for paper mill wastes may include suspended solids and B.O.D.; and for textile wastes may specify pH, B.O.D., suspended solids, etc. Standards also have been set for tannery wastes, metal pickling wastes and others, varying for different plants and different streams.

Washington. The State of Washington has adopted an unusual approach to pollution control. The Pollution Control Commission has not classified streams, does not require primary treatment as a minimum, has no exemptions, but issues permits and applies penalties and adopted in 1950 unique requirements for industrial wastes. Mr. E. F. Eldridge, Director and Chief Engineer of the Commission, stresses the fact that these requirements emphasize waste prevention measures rather than waste treatment processes. Certain specific standards for water quality and perhaps for effluent are said to be under consideration but the present standards are very general. They have been established for most of the types of industry in that state which discharge polluting wastes, and several examples will be outlined. For vegetable and fruit canneries and dehydration plants it is required that an effective type of 20-mesh screen be employed, and that screenings be disposed so that they cannot enter State waters. Where lye is used for the removal of skins, the wastes from the process must be impounded and discharged under controlled conditions.

For pulp and paper mills, wastes from the formation of the pulp sheet and from the production of paper must be handled by effective save-alls or partially closed white water systems or both, and the fiber loss must not be greater than 1% of production.

For wastes from slaughterhouses it is specified that holding pens and slaughterhouse floors be dry-cleaned before washing down, and that fleshings, paunch manure and blood be separately collected and disposed of as fertilizer or in any other satisfactory manner which will preclude stream pollution. Adequate grease traps also must be installed.

It should be noted that the good housekeeping measures in the foregoing are actual requirements and not mere suggestions. The approach of the state of Washington appears to merit serious consideration where stream pollution is not yet acute.

Oregon. The Oregon State Sanitary Authority has classified streams, requires a minimum of primary treatment, exempts acid and silt drainage from mines, issues permits, applies penalties and has established minimum standards requiring that sewage discharged into waters for which high degree treatment is needed shall be free of noticeable floating solids, oil, etc. and practically free of suspended solids; and shall indicate 85% B.O.D. reduction with no more than 50 p.p.m. B.O.D. in the effluent.

Where a lower degree of treatment is acceptable, largely because of greater available dilution in receiving waters, it is required that the effluent shall be free of noticeable floating solids, oil, etc.; that the suspended solids reduction be at least 55%; and that the B.O.D. reduction shall be not less than 35%, with a maximum of 125 p.p.m. B.O.D.

No treatment is required of sanitary sewage discharged into waters which in the opinion of the authority will not be damaged thereby. The foregoing are effluent standards but apply only to sewage; the standards for industrial waste discharges are based on stream quality.

California. The organization for pollution control in California is somewhat unique. In 1949 the California Legislature, after long study, passed a law under which the state is divided into 9 regions, based on drainage areas, each governed by a five member board appointed by the governor to represent the interests of water supply, industrial waste, irrigation, and city and county government. Each board has an executive officer and technical staff; the duties of these boards are to prescribe and monitor waste discharge requirements, develop plans and policies, and coordinate the interests of other agencies.

The regional boards are autonomous for regulatory purposes but their acts are subject to review by a State Board of 14 members representing the five fields set forth above plus industrial water, sewage disposal, and several others. Its membership must include the Directors of Public Health, Natural Resources, Agriculture, Fish and Game, and the State Engineer. Its duties are to formulate state-wide policies for pollution control, administer state-wide programs of research or financial aid in pollution control; allocate funds for administrative expenses and, where necessary, to review the acts of the Regional Boards.

This is a decentralized program which appears to be generally effective.

California's Pollution Control Boards do not classify streams nor require minimum treatment for industrial wastes (instead, case by case studies are made). They do have effluent standards; no type of waste is exempt; no permits are issued, but the Board can establish effluent and stream requirements. There are legal penalties for violations.

Pennsylvania. The Sanitary Water Board of Pennsylvania is an agency within the Department of Health, having jurisdiction over all matters pertaining to stream pollution, and comprises the Secretary of Health as Chairman, the Secretary of Forests and Waters, the Executive Director of the Fish Commission, the Secretary of Mines, and three members appointed by the Governor, representing the public. This brings around one table all those agencies of the state having to do with the waters of the Commonwealth. The Department of Health is the agent of the Board and the Division of Sanitary Engineering performs the Board's active work.

The program and basic policy can be recapitulated very briefly:

(1) The Board has grouped Pennsylvania's streams, on the basis of their use and condition, into those for which primary or complete or other degrees of treatment are required.

(2) Blanket minimum percentages of reduction from untreated sewage or industrial wastes have been established: the same for every town and industrial establishment on a given watercourse.

(3) More treatment only if the use or condition of the receiving stream makes it necessary.

Primary treatment is specified as the removal of practically all settleable solids and at least 35% of the biochemical oxygen demand; effective disinfection where necessary to control disease-producing germs; satisfactory disposal of sludge; and a final effluent suitable in the opinion of the Board for discharge into the public waters. In addition, oils, greases, acids, alkalis, toxic, putrescible, taste- and odor-producing substances and other substances inimical to the public interest in the receiving stream, must be removed.

"Complete" (i.e. "high-degree") treatment is similarly defined, except that the removal of practically all the suspended solids and at least 85% of the B.O.D. load is required, plus effective disinfection in all cases.

Intermediate treatment is defined in accordance with the need in each instance; and additional treatment, beyond the minimum, will be required in any specific case if the use and condition of the receiving stream, or increase in the size or capacity of the mill or municipality, make it necessary.

These are general requirements, subject to modification when in the opinion of the Board the use and condition of a stream warrants such change.

Exception is made only in the case of sewage, discharged to streams impregnated with acid coal mine drainage (exempt under the law), when such discharge does not create a condition inimical to the public interest. The law makes no mention of industrial wastes in this connection, and the Board requires such treatment as may be needful to protect the stream from further damage than that already caused by acid mine drainage.

STANDARDS FOR "NORMAL RAW WASTES"

Referring again to the policy of the Board whereby Pennsylvania's streams are divided into groups, with minimum treatment required for each group in terms of percentages of reduction from the raw sewage or industrial wastes:

It is to be understood that these are blanket percentages of reduction, required by the Board for all towns and industrial establishments on a given watershed. In order to apply these percentage reductions in such a way that plants having good housekeeping will not be penalized with respect to similar plants having poor housekeeping, "normal raw wastes" standards have been set up for a number of industries. Because of the extreme shortage of engineering personnel, the determination of such standards for cannery wastes in cooperation with the industry, is being indefinitely postponed. It will be resumed when men are available—unless the industry wishes to prepare suggested standards. If so, they certainly

will be carefully considered. Standards are needed with respect to B.O.D. and suspended solids.

INTERSTATE AGREEMENTS AND COMPACTS

One of the best indications of real progress in pollution control has been the development of interstate agreements and compacts, such as the Interstate Commission on the Delaware River Basin (INCODEL) (an agreement between New York, New Jersey, Delaware and Pennsylvania and backed by reciprocal legislation in each state), the Interstate Commission on the Potomac River Basin (INCOPOT) (a compact between Virginia, West Virginia, Maryland and Pennsylvania), and the Ohio River Valley Water Sanitation Commission (ORSANCO) (a compact between Illinois, Indiana, Kentucky, New York, Ohio, Virginia, West Virginia and Pennsylvania). The requirements established by INCODEL have set valuable precedents which have repeatedly been followed elsewhere. INCOPOT AND ORSANCO, through their working committees, are helping to advance the art and practice of pollution control within the mills as well as the development of improved methods of waste treatment and recovery.

It should be noted that an interstate compact requires Congressional approval, an interstate agreement does not.

There is no intention of attempting here anything more than an outline of the effluent standards established by these agencies. Many of the standards already are known to those interested, and copies are available to any who need them.

The Delaware River requirements established by Pennsylvania in accordance with the INCODEL agreement, are representative: The river is divided into four zones. For Zone I (from the New York-Pennsylvania State Line to Trenton, New Jersey, roughly 180 miles) where the upper river flows through the less densely populated rural portion of its basin, with little or no industrial pollution, the minimum requirements for sewage and industrial waste discharges call for effluents free of noticeable floating solids, color, oil, and suspended solids, and such that they will not cause noticeable turbidity in the river. The requirements call also for a reduction of at least 85% in the B.O.D., with a limit of 50 p.p.m. in the effluents themselves, and the dissolved oxygen of the river must not be reduced more than 5% on the basis of specified tests. In addition, the most probable number of organisms of the coli aerogenes group must not exceed one per milliliter in more than 10% of the samples nor more than 100 organisms of that group per milliliter in any single sample, and all effluents must be free of substances capable of producing offensive tastes and odors in public water supplies derived from the river, and sufficiently free of acids, alkalis, and other toxic or deleterious substances, that they will not create a menace to the public health nor be inimical to fish, animal or aquatic life.

The requirements for Zone 2 of the Delaware River (from Trenton, 23 miles to Pennypack Creek in Philadelphia) are substantially the same as those for Zone 1 except that the dissolved oxygen content of the river may be reduced by as much as 10% and the requirement with respect to sewage organisms is somewhat less rigid—the tides reach upriver to the City of Trenton.

For Zone 3 (from Pennypack Creek, 27 miles to the Delaware-Pennsylvania State Line) in effluents discharged to the river from an area of markedly increased industrial concentration, the total suspended solids and B.O.D. must show minimum reductions of 55% and 35% respectively, while the regulations state plainly that the intent is to restore the dissolved oxygen content of the river water in this zone to at least 50% of saturation, so that greater reduction than the minimum may prove necessary. It is required also that any effluent discharged within two miles of a water works intake or within prejudicial influence thereof shall be effectively treated with a germicide.

In Zone 4 (from the Delaware-Pennsylvania line to the Atlantic Ocean) where the river has reached an area of dense industrial and residential population, no specification is made for B.O.D. reduction other than to require such treatment as may be needed to prevent a nuisance, and effluents in the vicinity of recreational areas need not be sterilized from October 15 to May 15 of each year; but Pennsylvania does require sterilization throughout the year. In other respects the regulations for Zone 4 are closely similar to those for Zone 3.

The Ohio River Valley Water Sanitation Commission established in 1949 standards for the treatment of sewage discharges into the portion of the Ohio River known as the "Cincinnati Pool" between U. S. Engineer Corps Dams Numbers 36 and 37. These are effluent standards and require the substantially complete removal of settleable solids and not less than 45% of the suspended solids; and a minimum B.O.D. reduction of 65% or a lesser minimum reduction of 35% if as a result, the dissolved oxygen will not be made less than 4 p.p.m. at the bottom of the oxygen sag in the Ohio River below Cincinnati.

Later in 1949, standards were adopted for the "Pittsburgh Pool" of the Ohio River requiring the substantially complete removal of settleable solids from sewage and industrial wastes discharged to the pool, and the reduction of the B.O.D. by at least 50%.

In 1955, ORSANCO adopted basic industrial waste requirements (IW-1) as follows:

Industrial wastes (exclusive of mine drainage until such time as practical means are available for control) shall be treated or otherwise modified prior to discharge so as to maintain the following conditions in the receiving waters:

1. Freedom from anything that will settle to form putrescent or otherwise objectionable sludge deposits which interfere with reasonable water uses.
2. Freedom from floating debris, scum and other floating materials in amounts sufficient to be unsightly or deleterious.
3. Freedom from materials producing color or odor in such degree as to create a nuisance.

The Interstate Sanitation Commission of New York, New Jersey and Connecticut has set requirements for all discharges of sewage and industrial wastes to waters under its jurisdiction. For high degree treatment, there is required a 60% reduction in the suspended solids and such a reduction in the B.O.D. as will maintain the average dissolved oxygen in the receiving waters at not less than 50% saturation; B. Coli not to exceed 1 per cubic centimeter in half the samples tested.

For a lower degree of treatment, the suspended solids must be reduced by at least 10% and the oxygen demand lowered sufficiently to maintain the average dissolved oxygen content at not less than 30% saturation in New York Harbor and adjacent tidal waters. The Commission may advise municipalities, states or other bodies to move to abate pollution, and may bring legal action in the state involved, upon their failure to do so.

The New England Interstate Water Pollution Control Commission (Massachusetts, Connecticut, Rhode Island, New York, Vermont, and New Hampshire—Maine is eligible to join) is concerned with all interstate waters within the area. Its purpose is to classify interstate water according to highest use and coordinate a program of improvement.

The Tri-State Water Commission (North Dakota, South Dakota and Minnesota). The stream concerned is the Red River of the North. This Commission is a corporate body whose function is to study pollution of water supply.

SUMMARY AND CONCLUSIONS

Because of the many and diverse laws and problems the country over, it is difficult to summarize the roles of our numerous pollution control agencies. However, it is clear that almost every state has a law dealing directly with stream pollution control and in the two states which do not have such laws, health regulations can be applied. Moreover, practically all such laws provide penalties for violation, some including jail sentences in addition to fines in the discretion of the court.

Very few industries are exempt—one exemption being acid mine drainage from coal mines, because practical methods of treatment are not known.

There is a strong tendency toward cooperation between administrative agencies and the industries whose operation gives rise to polluting wastes. This cooperation is a fortunate thing, because only in that way can permanent and satisfactory pollution control be obtained.

Need for studies of treatment works performance. After works have been placed in regular operation for the treatment of industrial wastes or sewage, it becomes quite essential to check the adequacy of these works, as well as their routine performance. Without such data, we have no means of knowing with any sureness whether the permit issued for a given installation was correctly drawn up, or whether the plans approved are well or poorly suited to their purpose, or whether they are over- or under-designed in any given respect. There are no better means of developing or improving the factors of design; and using funds supplied by the Congress through Public Law 660, we are hopeful of obtaining several teams of men who can be trained to make such surveys.

Savings realized by industry incident to pollution abatement. One of the by-products of the program of pollution control is the waste saving incident thereto, but not usually realized by the establishment concerned until it actually begins waste treatment and maintains a decent program of good housekeeping. Savings almost always follow. Some may be by direct recovery of usable material; others are indirect and much more common—such as savings of water in the effort to reduce the volume of industrial wastes. Saving of water usually means a saving of heat, therefore of coal.

In addition to savings by the establishments where waste discharges originate, treatment frequently results in marked savings to downstream users by the provision of greater quantities of usable water, and by the reduction in the cost of treating that water before use in the process, or cooling systems, or boilers. These uses are quite common. Some years ago following a major spill in Pennsylvania, all except one or two complaints were received from industrial establishments and had to do with boiler water and cooling water.

Effect of Sucrose and Type of Spicing on the Quality of Processed Dill Pickles

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DURING THE PAST 25 YEARS, many advances have been made in our knowledge of the microbiological, chemical, and physical changes undergone by pickles in preparation, spicing and storage *(8,10)*. Reports have been published on the influence of cucumber holding time and temperature, processing time and temperature, and brine acidity on the flavor of pasteurized pickles *(2, 3, 5, 6, 7)*. Industrial "cuttings"[a] have been organized to evaluate commercial packs of pickles for general appearance, size grading, texture, and flavor. However, the flavor quality of all types of pickles frequently is very poor. In a Canadian study, on the basis of chemical, microbiological, and taste panel tests, Jones and Harper *(9)* reported that 56% of the dills, 82% of the sour mixed, 55% of the sweet mixed, and 50% of the miscellaneous samples they tested were below the desirable quality.

In a study of flavor quality in sweet pickles, Switzer and Fabian *(15)* expressed the opinion that flavor in pickles is more important than in some other food products because pickles are not considered a necessary part of the diet. These investigators further stated that "The flavor of pickles is due to taste, which includes their sweetness, sourness, saltiness, and spiciness, and to their odor, which is due to the volatile nature of acetic acid and to the essential oils in the spices used in their preparation." Therefore, it can be concluded that the flavor quality and consequent acceptability of finished pickles are influenced not only by the initial quality of the cucumber stock, the microbiological, chemical, and physical changes in processing, but also by the proper balance of acids, salt, spicing, and in some cases, sugar. The present paper is concerned with a critical study of the over-all quality of processed dill pickles as affected by type of spicing and by the addition of small concentrations of sucrose.

EXPERIMENTAL

Preliminary investigation

Methods and materials. Initial measurements of quality were made on 5 brands of commercially packed, processed dills, purchased from local markets. A laboratory taste panel of 14 members was trained, by the open discussion method, then individually, over a period of 2 weeks, to detect differences in quality factors between samples of processed dill pickles. The score card this panel developed for subsequent quality measurement of processed dill pickles is shown in Figure 1.

PICKLE SCORE CARD

Name_____ Date_____

Please evaluate each pickle sample for the quality factor listed below, using the appropriate scale.

Texture	Quality of pickling flavor	Presence of undesirable flavor	Kind of undesirable flavor	Overall reaction
+4 Hard or tough	0 Poor	0 None	1. Astringent	1. Dislike very much
+3	1	1 Slight	2. Bitter	2. Dislike moderately
+2	2	2	3. Medicinal	3. Dislike slightly
+1	3 Fair	3 Moderate	4. Metallic	4. Like slightly
0 Optimum	4	4	5. Musty	5. Like moderately
−1	5	5 Intense	6. Rancid	6. Like very much
−2	6 Good		7. Too acidic	
−3	7		8. Unbalanced spicing	
−4 Soft	8 Excellent		9. Soapy	
			10. Salty	

Sample	Color		Texture	Quality of pickling flavor	Presence of undesirable flavor	Kind of undesirable flavor	Overall reaction
	Good	Poor					

Figure 1

Comments:

Three brands of pickles were compared at each of 42 taste sessions. For objective measurements, 3 quart jars of each brand were pooled, the pickles sliced crosswise into 3/8 inch slices, and the ends discarded. Texture was determined by a shear press,[b] using 5 replications. The resistance of the pickle sample to penetration was recorded as pounds pressure per 75 g. of pickles. Steam distillation in a Seiller tube *(11)* was used for determining volatile acidity which was calculated as per cent acetic acid. Fixed acidity was calculated by difference between the total titratable acidity and the volatile acidity, and expressed as per cent lactic acid. The pH of the pickle homogenate, 1:2 dilution of drained pickle with water (w/v), was recorded.

The color of each pickle sample was measured by the Colormaster differential colorimeter.[c] Three color determinations were made per sample homogenate, 2:1 dilution of drained pickle with distilled water (w/v). The averaged readings were converted to their respective color coordinates *(12)* and the values expressed as number of shades of color deviation from a designated standard (a sample selected by the panel at the onset of the study as having optimum pickle color).

[a] National Pickle Packers Association annual meetings.

[b] Bridge Food Machinery Co., Philadelphia, Pa.

[c] Manufacturers Engineering & Equipment Corp., Hatboro, Pa.

Observations. There was a high degree of variability in all measurements between brands as well as within the same brand. In general, the pickles were not well liked; average scores ranged from 2.5 to 3.4, corresponding to ratings of *fair*. Scores for presence of undesirable flavors ranged from 1.6 to 3.5, *slight* to *moderate*, respectively. A high degree of correlation ($r = 0.96$) existed between shear press values for the individual samples and the panel's texture scores. However, shear press readings varied considerably between and within brands (560 to 820 lbs. pressure/75 g. samples). Neither the panel's scores for quality of the pickling flavor nor degree of undesirable flavor correlated with any of acidity measurements. All 5 brands were thought to be too acidic (predominantly acetic acid) and unbalanced in spicing. Although the colorimeter showed slight color differences between and among brands, the panel found the range of colors acceptable for processed pickles.

Main investigation

Preliminary study showed that main flavor defects were over-acidity and unbalanced spicing. Therefore, the main investigation was planned to test the effect of varying the type of spicing and of adding small amounts of sucrose to "balance" the acidity. Addition of sugar to non-sweet pickles as a fermentation aid is by no means a new idea. As early as 1899, sugar was added to fermenting pickle brines to accelerate and increase the formation of acids *(1)*. More recently, addition of sugar to salt stock or dill brines prior to or during fermentation was found to increase the proportion of bloaters with no significant change in brine acidity *(16)*. It was not reported whether the sugar imparted any flavor changes in the finished pickles.

Raw material. Pickles evaluated in the main investigation were packed to the order of the present authors, under standard commercial conditions by the Farm Food Co., Ceres, California, as follows: Pickles were taken from a 60° salometer [4] salt stock to which 1 lb. (0.5%) alum and 2 oz. solubilized turmeric per vat had been added. Salt content was reduced to 5° salometer, and the pickles divided into 2 groups. To one was added 1 lb. of genuine (dry) mixed pickling spices/50 gal. barrel; to the other, 0.75 oz. soluble dill oil and 0.50 oz. soluble pickling spices (15 spices). Pickles of 800 count, 1½ to 1¾ in. in diameter were packed cold into ½ gal. glass jars and covered with a brine of 18 grains [5] of vinegar and 46° salometer. The vinegar and salt cut-outs immediately after packing were 6–7 grains and 17° salometer, respectively. Further subdivision of the 2 pickle groups allowed addition of the following sugar concentrations:

Added Sucrose (by wt.)	Cut-out Sucrose (by wt.)
3.0%	1.0%
4.5	1.5
6.0	2.0

A control sample with no added sugar was packed for each spicing group. Capped jars of pickles were pasteurized at 140° F. for 45 min. and then cooled in water to 95° F. A period of 10 days elapsed before evaluations were initiated, the pickles being kept at room temperature throughout the period of testing.

Objective measurements. In addition to the measurements of texture, color and acidity described in the preliminary study, the salt content of the brine and of the pickle homogenate was determined using an adaptation of the Schales and Schales mercuric nitrate method *(13)*.

Subjective evaluation. The same panel of 14 judges tested the pickles using the score card in Figure 1. A balanced, incomplete block design with 3 samples per session was used for evaluation of pickles within each type of spicing. In addition, to determine the differences between types of spicing at each sugar level, the more sensitive method of paired comparison was used. Each pickle sample was evaluated at 12 separate panel sessions for each of the 2 methods of comparison. The multiple and paired comparisons were analyzed by analysis of variance and Student's t-test, respectively *(14)*.

[4] A salometer degree is approximately equal to percent salt multiplied by 4 *(4)*.

[5] One-grain strength of vinegar is equivalent to 0.1% acetic acid *(4)*.

RESULTS AND DISCUSSION

Effect of sugar. The most outstanding finding made in this study was the improvement of flavor quality by the addition of sucrose. Figure 2 shows the average scores for pickling flavor. Despite the fact that all the pickles were considered only *fair* in flavor quality, the flavor improvement with the addition of sucrose was a significant one. Pickles with genuine spicing were improved in flavor to a greater extent than were those containing spice oils. There was a slight, although not significant, drop in the average flavor scores at the 1.0% sucrose level, compared with the controls. As will be pointed out later, it is believed the excessive amount of salt in these 2 samples detracted from their acceptability. Average flavor scores for samples containing 2.0% sucrose were significantly higher than those assigned to the controls. Average scores for presence of undesirable flavor are in exact opposition to scores for desirable flavor (Figure 2). Although it is not known whether more than 2% sucrose would have been accompanied by higher flavor quality scores, it is felt that sugar levels much beyond 2% would be perceived as sweetness, and would be undesirable in processed dill pickles. This point will be taken up in a further study.

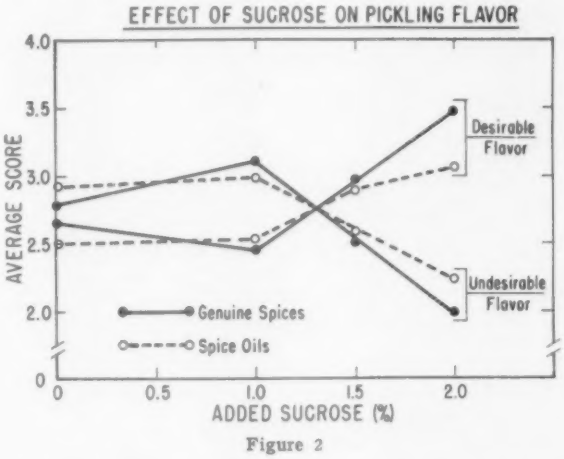

Figure 2

A summary of the effect of small quantities of sucrose on various quality factors is given in Table 1. The role of sugar appears to have been two-fold: (a) counteraction of the apparent over-acidity of the control samples, and (b) enhancement of the desirable spicing flavors.

Numerical values for the panel's over-all reactions are almost identical to the respective flavor scores. As would be expected, the panel reacted most favorably to pickles with the most acceptable flavor.

Subjective scores for texture (Table 1) show that the entire pack approximated optimum textural quality (a score of 0) and none was affected by the addi-

TABLE 1

Effect of sucrose on quality factors in dill pickles
Average values

	Genuine spices						Spice oil					
	Sugar levels				Level of significance	L.S.D.[1]	Sugar levels				Level of significance	L.S.D.[1]
	0	1.0%	1.5%	2.0%			0	1.0%	1.5%	2.0%		
Quality Factors												
Flavor	2.69	2.45	2.91	3.46	.001	0.49	2.50	2.57	2.89	3.09	.05	0.59
Undesirable flavor	2.77	3.17	2.51	1.98	.001	0.43	2.93	2.97	2.56	2.24	.01	0.50
Type of undesirable flavor	Acid	Acid salty	Acid and unbalanced spicing	Unbalanced spicing	.....	.....	Acid salty	Acid and unbalanced spicing		Unbalanced spicing	.....	.....
Over-all reaction	2.76	2.41	2.96	3.27	.001	0.56	2.42	2.42	2.62	2.90	.05	0.45
Texture												
Subjective	−0.5	0	−0.1	−0.1	N.S.	.....	−0.1	+0.1	+0.3	+0.1	N.S.	.....
Objective (lbs. pressure)	407	412	441	440	N.S.	.....	439	471	482	498	N.S.	.....
Color												
Opjective[2]	0	35	27	31	N.S.	.....	0	27	30	33	N.S.	.....
Acidity												
Total	0.66	0.60	0.70	0.74	N.S.	.....	0.60	0.66	0.65	0.60	N.S.	.....
Volatile	0.38	0.32	0.38	0.37	N.S.	.....	0.35	0.39	0.37	0.33	N.S.	.....
Fixed	0.28	0.28	0.32	0.37	N.S.	.....	0.25	0.27	0.28	0.27	N.S.	.....
Fixed/vol.	0.73	0.90	0.86	1.02	.....	.....	0.72	0.73	0.78	0.85	.....	.....
pH	3.51	3.43	3.30	3.31	N.S.	.....	3.62	3.40	3.37	3.42	N.S.	.....

[1] Least significant difference at the 5% level of probability.
[2] Shades of color deviation from the control.

tion of sucrose. The color of sugar-containing samples, as determined by the colorimeter, did not deviate significantly from controls. In addition, the panel found all samples to be within the range of acceptable color.

Data collected on total, volatile, and fixed acidity showed little variation between samples. The ratio of fixed to volatile acidity differed between samples especially in the pickles containing the genuine spices. However, correlations between this ratio and flavor scores were not statistically significant. The pH did not differ significantly among or between the two groups of pickles.

Salt values (Table 2) show wide variation from sample to sample. Less salt was present in the pickle homogenate than in the brine. Highest salt values (5.03% and 4.21% NaCl) coincide with the samples least liked within each type of spicing, indicating the necessity for a balance between acid, salt, sugar, and spicing.

TABLE 2

Salt content of brine and pickles[1]

(Chloride content expressed as % NaCl)

Sucrose	Genuine spices		Spice oils	
	Brine	Pickles	Brine	Pickles
Per cent				
0	4.86%	4.00%	5.60%	4.21%
1.0	6.45	5.03	4.78	3.66
1.5	4.74	3.83	5.00	4.05
2.0	4.22	2.88	4.74	3.66

[1] Each value represents an average of 6 determinations.

Effect of spicing. At all sugar levels, the panel of judges considered genuine spicing superior to spice oils (Table 3). At the 1.0% sugar level, a significant difference was not established between the types of spicing, possibly because of the undesirable high salt content of the "genuine spice pack." The amount of undesirable flavor ascribed to the pickles was greater for those containing "spice oils." Significant differences in undesirable flavor were obtained only at the 1.5% sugar levels. Type of spicing had no influence on texture, color, or acidity of the samples.

TABLE 3

Influence of type of spicing on the flavor quality of processed dill pickles

Sucrose level	Type of spicing	Pickling flavor		Undesirable flavor	
		Average score[1]	Level of significance	Average score[2]	Level of significance
0%	Genuine vs. Spice oil	3.62 2.88	.05	2.92 3.17	N.S.
1.0%	Genuine vs. Spice oil	2.74 2.47	N.S.	3.04 3.43	N.S.
1.5%	Genuine vs. Spice oil	3.48 2.61	.05	2.18 3.00	.01
2.0%	Genuine vs. Spice oil	3.42 1.55	.01	1.95 2.61	N.S.

[1] Scored on a nine-point scale where 0 = *poor* and 8 = *excellent*.
[2] Scored on a six-point scale where 0 = *none* and 5 = *intense*.

SUMMARY

A trained taste panel observed two main flavor defects in commercially processed dill pickles; high apparent acidity (acetic acid) and unbalanced spicing as indicated by harsh flavors. Consequently, processed dill pickles were packed with two spicings; genuine and spice oils, and at three sugar levels; 1.0, 1.5, and 2.0% sucrose by weight. Addition of 2.0% sugar improved the pickle flavor quality significantly over the controls by counteracting the apparent over-acidity and by enhancing the spicing flavors. High salt levels (4.21 and 5.03% NaCl) upset the balance between acid, sugar, salt, and spicing in two of the

samples and thereby contributed to the flavor differences observed. More salt was found to be present in the brine than in the whole pickle. Pickles containing genuine spicing were considered superior in flavor to those containing spice oils. Color, texture, volatile and fixed acidity, and pH were unaffected by the addition of sucrose or by the type of spicing.

Acknowledgments

Appreciation is extended to Mrs. Marlene Estelle for her assistance in the laboratory. The pickles were packed on order by Mr. Lou Abate, Farm Food Company, Ceres, California. The interest and cooperation of the taste panel is gratefully acknowledged. This study was supported, in part, by grants-in-aid from the Sugar Research Foundation, Inc., and from the American Spice Trade Association.

LITERATURE CITED

1. Alderhold, R. Untersuchungen über das Einsäuern von Fruchten und Gemüsen, Part II, *Cent. für Bakt.*, **5**, 511–514 (1899).
2. Anderson, E. E., Ruder, L. F., Esselen, W. B., Jr., Nebesky, E. A., and Labbee, M. Pasteurized fresh whole pickles. II. Thermal resistance of microorganisms and peroxidase. *Food Technol.*, **5**, 364–368 (1951).
3. Cook, J. A., Pflug, I. J., and Ries, S. K. Effect of cucumber holding time and temperature on the quality of pasteurized fresh whole pickles. *Food Technol.*, **11**, 216–218 (1957).
4. Cruess, W. V. *Commercial Fruit and Vegetable Products.* 2nd ed., 1938. Chap. XXV, McGraw-Hill Book Co., Inc., New York.
5. Esselen, W. B., Jr., Anderson, E. E., Ruder, L. F., Jr., and Pflug, I. J. Pasteurized fresh whole pickles. I. Pasteurization studies. *Food Technol.*, **5**, 279–284 (1951).
6. Esselen, W. B., and Anderson, E. E. Effect of handling and storage of raw material on quality retention in fresh pack pickle spears during storage. *Glass Packer*, December, 1956.
7. Esselen, W. B., and Anderson, E. E. The pasteurization of pickles. *Glass Packer*, February, 1957.
8. Etchells, J. L., Jones, I. D., and Bell, T. A. Advances in cucumber pickling. *Yearbook of Agriculture*, 229–239 (1950–51).
9. Jones, A. H., and Harper, G. S. A preliminary study of factors affecting the quality of pickles on the Canadian market. *Food Technol.*, **6**, 304–308 (1952).
10. Jones, M. A. The brining and pickling of cucumbers and other vegetables. *Publications and Abstracts, 1938–1955.* U. S. Food Fermentation Lab. & North Carolina Ag. Exp. Sta., Ag. Res. Serv., U.S.D.A., March, 1956.
11. Joslyn, M. A. *Methods in Food Analysis Applied to Plant Products.* 1950. Chap. XIV, Academic Press, Inc., New York.
12. Judd, D. B. *Color in Business, Science and Industry.* 1952. John Wiley & Sons, Inc., New York.
13. Schonherz, Z. The determination of salt in brines, pickles, salted meats and seasoning by titration with mercuric nitrate solution. *Food Manuf.*, **30**, 460 (1956).
14. Snedecor, G. W. *Statistical Methods.* 4th ed., 1946. The Iowa State College Press, Ames.
15. Switzer, R. G., and Fabian, F. W. 200 (consumers) tell what they prefer in pickle sweeteners. *Food Inds.*, November, 1940.
16. Veldhuis, M. K., Etchells, J. L., Jones, I. D., and Veerhoff, O. Influence of sugar addition to brines in pickle fermentation. *Food Inds.*, 54–56, Oct.: 48–50, Nov. (1941).

Effect of Certain Bacterial Inhibitors on Shelf-Life of Fresh Fryers[a]

(Manuscript received August 16, 1957)

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The length of time which poultry meat remains in a satisfactory condition in distribution channels is an important economic consideration in the broiler-fryer industry. This industry has grown phenomenally. Official records were not kept until 1934, but by 1956 over 16 pounds per capita were being consumed. Considering this high rate of consumption and the narrow margins of profit obtaining in processing and merchandising channels, any method used in the processing plant to extend shelf-life and reduce losses should be encouraged.

Sanitation in processing plants accompanied by proper refrigeration and handling influence the growth of bacteria and hence the length of time poultry meat remains acceptable. Gunderson, Rose and Henn *(5)* found that most commercially eviscerated poultry exhibited a very heavy surface microbial population. Coliform organisms were especially prevalent. Ayres, Ogilvy and Stewart *(1)* demonstrated that birds processed under sound sanitary practices had good keeping time, whereas those processed by insanitary methods developed slime quickly.

[a] Presented at the Seventeenth Annual Meeting of IFT, Pittsburgh, May 15, 1957. This study was supported in part by the North Central Regional Project NCM-7. Scientific paper No. 2110 from the Michigan Agricultural Experiment Station.

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[e] Department of Foods and Nutrition.
[f] Department of Foods and Nutrition.

Goresline, Howe, Baush and Gunderson *(4)* reported that the bacterial count on eviscerating tables with continuous running water ranged from 4,000 to 45,000 organisms per square centimeter, but those with no water had a count of 700,000 organisms per square centimeter. An inplant chlorination program using 10 and 20 p.p.m. available chlorine, reduced bacterial counts on birds 60% and 93%, respectively.

Miller *(8)* reported the effects of dipping fryers in water containing 1,000 p.p.m. free chlorine for 30 seconds and then cooling in ice water containing 10 p.p.m. free chlorine. Odor and appearance observations indicated that birds from this treatment were only slightly off-odor after 18 days storage, whereas control birds were already decomposed. Inplant chlorination at 10, 20 and 45 p.p.m. lowered counts on equipment and on poultry carcasses, eliminated plant odors, and reduced cleanup time by more than 33%. Drewniak, Howe, Goresline and Baush *(2)* demonstrated that chlorinated snow did not prove to be more effective as a sanitizing agent than did snow made from plain water. Ziegler and Stadelman *(11)* demonstrated that chlorine in cooling water significantly increased shelf-life of fryers and that this treatment had more effect on birds processed at 128° F. than on those processed at 140° F.

Tarr, Southcott and Bissett *(10)* studied the effects of 15 antibiotics for preserving fish. Aureomycin, terramycin and chloromycetin, in order named, were most effective growth inhibitors of natural mixed bacterial flora. Tarr, Boyd and Bissett *(11)* reported that ices containing 1 to 4 p.p.m. chlortetracycline markedly retarded fish spoilage. Weiser, Goldberg, Cahill *et al. (12)* infused beef with aureomycin and found spoilage was retarded when refrigeration was delayed.

Goldberg, Weiser and Deatherage *(3)* found that chloromycetin, terramycin and aureomycin were effective in increasing the keeping quality of fresh ground beef. Kohler, Broquist and Miller *(6)* reported that aureomycin was more effective in controlling poultry spoilage than were nine other antibiotics tested. Ziegler and Stadelman *(13)* increased shelf-life of poultry 6 to 7 days by a 10 minute dip in solutions containing 10, 20 and 40 p.p.m. of aureomycin. Slime and odor tests were used to evaluate shelf-life.

This project was designed to evaluate the effects of chlorine (20 p.p.m.), chlortetracycline[a] (10 p.p.m.), and oxytetracycline[b] (10 p.p.m.) on shelf-life of ready-to-cook fryers and to test shelf-life by odor of raw birds, bacterial populations of skin surface and by cooked flavors.

EXPERIMENTAL PROCEDURE

Processing and treatment. Sixty commercially produced fryers were obtained for each of 2 separate trials. Birds were slaughtered in the usual manner and scalded at 130° F. prior to feather removal. After the birds were dressed they were hung on shackles, eviscerated and split into halves. Each half was washed in clean running water and then placed in the appropriate cooling tank containing ice water. The tanks contained ice water plus 10 p.p.m. chlortetracycline, 10 p.p.m. oxytetracycline, 20 p.p.m. chlorine, and no treatment, respectively.

The birds remained in the cooling tank for 4 hours after which they were ice packed in stainless steel pans containing drainage outlets. The pans were placed in a refrigerator at 45° F.

Evaluation. In Trial 1, birds were evaluated each Monday, Wednesday and Friday, but in Trial 2 they were evaluated every 2 days. On each evaluation day one-half fryer from each treatment was carefully removed and placed in a polyethylene bag. Each bird was then evaluated for raw odor by a selected panel of 4 persons. Each bird was then swabbed and in Trial 2 rinsed according to method described by Mallmann, Dawson, Sultzer and Wright *(7)*.[1] Suitable dilutions in water were made. Inoculated TGE agar plates were incubated at 20° C. for 3 days. The fryers were then washed, cooked, and evaluated for flavor and acceptability by a 5-member panel in the Foods and Nutrition Department using a 7-point score card.

RESULTS AND DISCUSSION

Bacterial counts. Figure 1 shows the number of bacteria found on the birds of each treatment held from 0 to 18 days. After processing, bacteria counts approximated 1 x 10^3 organisms. The birds treated with chlortetracycline had only slightly lower counts

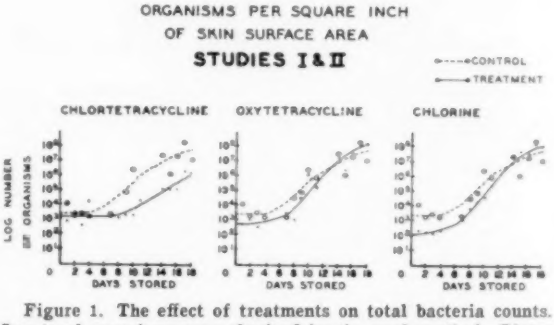

Figure 1. The effect of treatments on total bacteria counts. Counts of organisms were obtained by the swab method. Plates were incubated for three days at 20° C. on tryptone-glucose-extract agar.

than controls immediately after processing, but the difference increased with time. A count of 1 x 10^6 organisms per square inch is the point at which rejection of raw birds by odor can be expected according to McVicker *(9)*. Bacterial counts on the control birds reached this stage after about 10 days storage and the birds treated with chlortetracycline after 16 days. After 18 days the treated birds reached a count of 1 x 10^7 organisms, whereas the counts found on control birds amounted to 1 x 10^9 organisms.

Oxytetracycline was less effective in controlling bacterial numbers than was chlortetracycline. Numbers of bacteria found on birds treated with oxytetracycline were slightly below the number found on untreated birds during the first 12 days of storage. Ten days after treatment the counts reached 1 x 10^6. Based on the assumption that birds are not acceptable with a bacteria population of 1 x 10^6 organisms, this meant an extension in acceptability by two days beyond untreated birds. In this study the birds cooled in chlorine had fewer bacteria than the

[a] "Aeronize" furnished by American Cyanamid Company.
[b] "Biostat" furnished by Charles Pfizer & Company, Inc.

[1] This method was described at the 1957 IFT Meeting and will be submitted for publication.

controls during the entire period. These birds reached the bacterial level of 1 x 10^6 organisms per square inch after 10 days of storage. After the same storage the numbers of bacteria on chlorine treated birds increased rapidly and were practically the same as those on the untreated birds after 15 days storage.

Raw odors. The average odor score for all birds (uncooked) declined constantly after processing. During the first week the odor of untreated birds averaged slightly higher than did that of birds cooled in chlortetracycline solution (Figure 2). However,

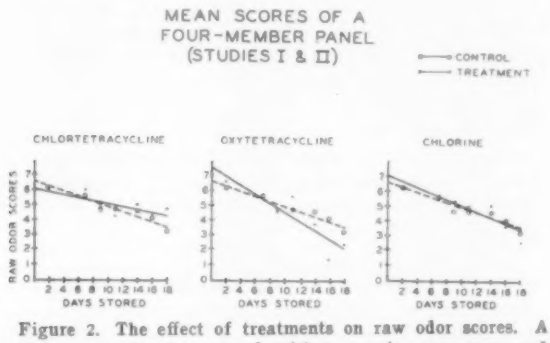

Figure 2. The effect of treatments on raw odor scores. A scoring range of 1–7 was used, with 1 meaning very poor and 7 meaning excellent.

after 8 days the treated birds showed higher average odor scores and maintained this superiority throughout the remainder of the holding period. No differences were found in odor scores from chlorine treated and control birds, but those treated with oxytetracycline were high during the first week and lowest during the last week of storage.

Flavor. Average flavor scores were obtained for all birds which had previously been given odor scores. Figure 3 shows the average flavor scores for birds of

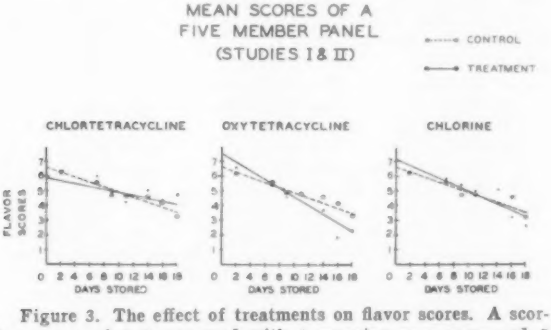

Figure 3. The effect of treatments on flavor scores. A scoring range of 1–7 was used with 1 meaning very poor and 7 meaning excellent.

each treatment compared with flavor of control birds. The regression lines in this figure are very similar to those in Figure 2. The birds cooled in chlortetracycline had lower average flavor scores than did the control birds for several days after processing, but higher scores during the final week of holding. Flavor scores of the birds cooled in oxytetracycline were higher than the controls at first but were low after 10 days of holding. The flavor of chlorine treated birds was essentially the same as that of control birds throughout the holding period.

SUMMARY

An evaluation of the effects on acceptable fryer shelf-life of chlorine and the antibiotics, chlortetracycline and oxytetracycline was made. Data from two replicate studies were analyzed and presented. Shelf-life was determined by a combination of bacterial counts, raw odor evaluations and cooked flavor.

Fryers cooled in ice water containing 10 p.p.m. chlortetracycline had lower bacterial counts and a longer shelf-life, as evaluated by raw odors and cooked flavor, than did those cooled in ice water, ice water plus chlorine and ice water plus oxytetracycline. Cooked flavor differences were less noticeable. Odor and flavor scores of the chlortetracycline treated birds were lower than controls during the first 4 days after processing, but were higher during the final week of evaluation.

Oxytetracycline and chlorine, in these two trials, were both less effective than chlortetracycline in extending shelf-life of fryers.

LITERATURE CITED

1. Ayres, J. C., Ogilvy, W. S., and Stewart, G. F. Post mortem changes in stored meat. I. Microorganisms associated with development of slime on eviscerated cut-up poultry. *Food Technol.*, **4**, 199 (1950).
2. Drewniak, E. E., Howe, M. A., Goresline, H. E., and Baush, E. R. Studies on sanitizing methods for use in poultry processing. U. S. D. A. Circular (1954).
3. Goldberg, H. S., Weiser, H. H., and Deatherage, F. E. Studies on meat. IV. The use of antibiotics in preservation of fresh beef. *Food Technol.*, **7**, 165 (1953).
4. Goresline, H. E., Howe, M. A., Baush, E. R., and Gunderson, M. F. In-plant chlorination does a 3-way job. U. S. Egg and Poultry Magazine, **57**, 12 (1951).
5. Gunderson, M. F., Rose, K. D., and Henn, M. J. Poultry boning plants need bacteriological control. *Food Inds.*, **19**, 1516, 1609 (1947).
6. Kohler, A. R., Broquist, H. P., and Miller, W. H. Chlortetracycline and the control of poultry spoilage. *Food Technol.*, **9**, 151 (1955).
7. Mallmann, W. L., Dawson, L. E., Sultzer, B., and Wright, H. Studies on microbiological methods for predicting shelf-life of dressed poultry. *Food Technol.*, 12, 122 (1958).
8. Miller, M. W. Using in-plant chlorination in chilled plant poultry operation. *Proceedings, Fact Finding Conference*, Institute of American Poultry Industries (1957).
9. McVicker, R. J. The effect of certain bacterial inhibitors on shelf-life of fresh poultry meat. (Michigan State University, Thesis, 1957).
10. Tarr, H. L. A., Southcott, B. A., and Bissett, H. M. Experimental preservation of flesh foods with antibiotics. *Food Technol.*, **6**, 363 (1952).
11. Tarr, H. L. A., Boyd, J. W., and Bissett, H. M. Experimental preservation of fish and beef with antibiotics. *J. Ag. Food Chem.*, **2**, 372 (1954).
12. Weiser, H. H., Goldberg, H. S., Cahill, V. R., Kunkle, L. E., and Deatherage, F. E. Observations on fresh meat processed by the infusion of antibiotics. *Food Technol.*, **7**, 525 (1953).
13. Ziegler, F., and Stadelman, W. J. The effect of aureomycin treatment on the shelf-life of fresh poultry meat. *Food Technol.*, **9**, 107 (1955).
14. Ziegler, F., and Stadelman, W. J. Increasing shelf-life of fresh chicken meat by using chlorination. *Poultry Sci.*, **34**, 1389 (1955).

Effects of Curing, Storage and Dehydration on the Mono- and Disaccharides of the Sweet Potato

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CHANGES IN CONCENTRATION of starch and total and reducing sugars during curing *(6, 25)*, storage *(9, 22, 23, 25, 41, 49)*, cooking *(9, 20, 21, 43, 53)*, and canning *(9, 48)*, of the sweet potato *(Ipomoea batatas)* have been reported. Generally, the identity of the sugars, the mechanism by which starch is converted to sugar, and the possibility of sugar being converted to starch during storage have not been determined. In 1890, Stone *(45)* reported the presence of sucrose in the sweet potato. The distribution of starch, "glucose," and sucrose in sweet potatoes as affected by fertilizer practice, duration of storage, and variety was investigated by the South Carolina Agricultural Experiment Station *(27, 41)*. Miyake *(37)* extracted glucose, fructose and sucrose from sweet potatoes and Hasselbring and Hawkins *(22)* reported changes in distribution of starch, reducing sugars, and sucrose in sweet potatoes after digging and during storage. Gore in 1920–1923 *(21)* was apparently the first to recognize the role of amylase inherent in the sweet potato in converting starch to dextrins and maltose at elevated temperatures and reported data on such conversion during cooking. In 1926, Culpepper and Magoon *(9)* reported a study of the relation of storage to the canning quality of 32 varieties of sweet potatoes in which extensive data were obtained on the changes in sucrose and reducing sugars that occurred before and after cooking the freshly harvested, cured, and stored roots. They recognized the formation of maltose at cooking temperatures but did not identify the monosaccharide components of the reducing sugars. Since that time reports on the sugars in sweet potatoes have been concerned with the products obtained from the degradation of starch *(8)*, loss of starch in curing and storage *(25)*, the correlation between sugar content and total solids in the root juice as determined by the refractometer *(49)*, and additional references to concentrations of total and reducing sugars. More recently, work has been reported from Japan on the nutritional chemistry of sweet potatoes; however, only total and reducing sugars are reported *(30)*. Similar results were also reported for changes in chemical composition during germination, growth, and preservation *(46)*.

Recently, chromatographic techniques have indicated that the sugar components might be detected more accurately both qualitatively and quantitatively *(20, 28, 36)*. This paper is concerned with the qualitative and quantitative changes in the major sugar components of the Unit I Porto Rico Variety during storage in the raw state and after dehydration, and is one of a series reporting extensive investigations on various phases associated with dehydration of sweet potatoes *(2, 3, 31, 32)*.

MATERIALS AND METHODS

Roots. Raw and dehydrated samples made available for this investigation were received and processed at the SRRL *(2)* from 50-pound sublots shipped periodically from the Louisiana Agricultural Experiment Station, Baton Rouge, Louisiana. Sample sublots came from an original lot of approximately 2000 pounds of Unit I Porto Rico variety, grown in West Feliciana Parish, Louisiana, and harvested in October 1952. Variety, climate, fertilization, and time of harvest were assumed to have the same degree of influence on all potatoes used in these experiments. All handling and processing conditions *(2)* were standardized and their effects were likewise assumed to be similar.

Storage conditions and sampling. After harvesting, the roots were cured for 10 days at 85° F. and 80–85% R.H., divided into approximately 50-pound lots, and stored in open-latted crates at 60° F. for 6 months. No selection of roots was made during the packing of the crates or positioning of the crates in storage. One crate was considered a sample. Samples were shipped to the SRRL at monthly intervals after curing (traveling time—approximately 3 hours). On arrival at the Laboratory, 5 roots weighing 2–3 pounds were selected, 1 each from the vicinity of the 4 corners and 1 from the center of the crate. The remainder of the crate was diced and dehydrated the same day and a 5-gram sample was removed and stored at 42° F. in a tightly sealed glass bottle.

Extraction. Surface dirt was removed from the roots which were then rinsed and blotted dry. Each root was cut into pieces approximately ½ by 1 inch and ground immediately in a home food chopper. After mixing and quartering 3 times, a 200-gram sample was mixed with sufficient hot 95% ethanol to make the mixture 80% by weight with respect to ethanol. Exhaustive extraction was conducted according to the method of Magoon and Culpepper *(35)* with the addition of blending the residue, after removal of the second supernatant, in a Waring[b] blender with sufficient 80% ethanol to make a slurry. Extraction in the Soxhlet was conducted for 3 periods as follows: 1 hour, 5 hours, and 8 hours. If the last extract was negative for sugars it was discarded and extraction discontinued. The remaining extracts were combined, alcohol was removed on the steam bath and the aqueous residue was freeze-dried. Last traces of moisture were removed by exposure to P_2O_5 in a desiccator.

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[b] Mention of a product by name does not constitute a Department of Agriculture recommendation of that product over similar products. Product names are supplied for scientific reasons; namely, to permit precise duplication of experimental procedures.

Since it had already been shown that no changes took place in alcoholic solution *(38)*, these were accumulated and stored at 42° F. for periods of approximately 2 months to permit freeze-drying a group of samples simultaneously.

Dehydrated samples of 50 g. (equivalent to approximately 200 g. of raw material) were reconstituted by soaking for 2 hours in distilled water at 60° C. in a ratio of 1 to 1.7. The previously published ratio of 3.5 parts of water to 1 part dice required for taste panel evaluation *(31)* was reduced to keep down the volume of 95% ethanol added for the extraction. After rehydration, extraction was conducted as outlined for the raw samples.

Deionization, qualitative, quantitative analyses. Deionization of the alcohol solubles was conducted according to the method of Williams and Bevenue *(52)* and the water-clear solutions of sugars were shell-frozen and held at −10° F. until they were lyophilized. The last traces of moisture were removed by exposure to P_2O_5 in a desiccator. Portions of the extracted materials were weighed to constant weight after drying in a vacuum oven at 60° C. for the purpose of calculating total solids and percentage composition.

Tentative identification was made by chromatographing (descending technique) spots of the deionized sugars on strips of S&S 602 ED [b] paper adjacent to spots of known sugars and irrigating with a mixture of l-propanol, ethyl acetate, and water in a ratio of 7:1:2 respectitvely according to the method of Albon and Gross *(1, 34)*. The temperature during irrigation ranged from 76–78° F. Sprays or dips for identification purposes included silver nitrate *(47)*, 2,3,5-triphenyl tetrazolium chloride *(47)* a modified Fleury reagent followed by p-anisidine phosphate *(33)* and the Godin reagent *(19, 34)*.

Two dimensional chromatography using the l-propanol:ethyl acetate:water mixture as the first irrigant followed by water saturated phenol as the second was used as a means of confirming the initial qualitative analysis. Successively on different chromatograms spots of 1 or 2 known sugars were superimposed on the extract spot from the roots to determine if the known sugars would assume the correct positions of the sugars suspected to be present.

Microscopical identification of the chromatographically separated sugars by preparation of the 2,4-dinitrophenylhydrazone dioxane solvates according to the method of White and Secor *(50, 51)* were made and compared with known derivatives. Crystals resembling the characteristic needles obtained with glucose were also obtained with maltose and sucrose. Fan-shaped needle clusters were obtained with fructose similar to those published by White and Secor *(51)*. Derivatives were not obtained in quantity sufficient for melting points. As was to be expected, a reaction did not take place with inositol. This compound was identified by the distinctive orange color obtained with the modified Fleury reagent *(33)*.

The descending chromatographic technique was also used with l-propanol:ethyl acetate:water = 7:1:2 for the quantitative determination of the principal sugars in the roots. Each sample was replicated 4 times and each strip (S&S 602 ED) [b] was irrigated and dried 4 successive times before complete separation between glucose and fructose was obtained. Solutions containing 100 to 150 mg. of the sugar extracts in 1 ml. of 50% ethanol were spotted on the strips with a Gilmont [b] ultramicroburet. Each spot contained 4 μl. and a total of 32 μl. per strip were used for each determination. Guide strips on either side of the chromatogram were removed and developed with silver nitrate for locating the spots. The method used was similar to that published by Dimler *et al. (10)*. Excised strips containing single sugars were eluted overnight by placing a quarter inch of the strip between 2–2 in. x 2 in. glass slides *(10)* which were supported in the same troughs used for irrigating chromatograms. Only 3–4 ml. of eluate were collected. This volume was transferred with a minimum volume of distilled water to conical volumetric tubes after being filtered through medium sintered glass filters to remove lint. Duplicate aliquots of 2 ml. each were removed from each sample for determination of the sugar content by the anthrone reaction. Only anthrone purified by the method of Gilman *(15)* and melting between 157–160° C. was used and fresh reagent *(12)* was prepared each day. Since Koehler *(29)* had previously shown that the interval of heating was critical particularly in the case of fructose, and Helbert and Brown *(24)* had also shown that the temperature to which the reaction mixture was heated should be controlled, the 2 methods were combined and standard curves were determined for the 4 sugars under consideration. Final temperatures and time intervals were as follows: fructose—10 minutes at 60° C.; sucrose—12 minutes at 90° C.; and, maltose and glucose—16 minutes at 90° C. At the expiration of the heating interval, all samples were plunged in an ice and water bath for 5 minutes to stop the reaction. Color measurements were made with the Beckman [b] Spectrophotometer at 620 mμ. Analysis of variance followed by Duncan's Multiple Range Test *(11)* were used for detecting significant differences between means at the 0.05 probability level. Quantitative determinations for inositol and starch were made according to the methods of Platt and Glock *(39)* and Steiner and Guthrie *(44)* respectively.

RESULTS

In this paper "dehydrated products" refers to dehydrated dice prepared from raw roots of varying quality. The terms, "freshly harvested, cured and/or stored" refer to the condition of the raw roots from which a particular dehydrated product is made. None of the dehydrated samples were stored.

Total solids based on the moisture content of raw sweet potatoes varied irregularly with storage (Table 1, column 3).

TABLE 1

Effects of curing, storage and dehydration on the solids and alcohol solubles in raw sweet potatoes and their dehydrated products

Storage of raw materials	Moisture[1]	Solids calculated	Dried residue from alcohol extraction[2]	Dried alcohol solubles[3]	Total solids determined	Per cent solids recovered
			Raw[4]			
	%	g.	g.	g.	g.	%
0 days (fresh)	71.0	58.0	51.23	14.60	65.83	113.5
10 days (cured) 60° F.	70.0	60.0	48.56	13.86	62.42	104.0
1 mo.	71.9	56.2	43.60	14.02	57.62	102.5
4 mo.	70.1	59.8	41.39	15.39	56.78	95.0
6 mo.	71.5	56.9	39.03	17.17	56.20	98.8
			Dehydrated[5]			
0 days (fresh)	6.62	46.89	20.99	25.77	46.76	99.7
10 days (cured) 60° F.	6.05	46.98	21.95	24.96	46.91	99.9
1 mo.	5.98	47.01	21.31	26.56	47.87	101.8
4 mo.	6.63	46.69	15.56	28.59	44.15	94.6
6 mo.	5.32	47.34	16.09	29.77	45.86	96.9

[1] AOAC Method, p. 336, 5th ed., 1940, of *Methods of Analysis:* 6 hrs. in vacuum oven at 70° C. and 20–26 in. vacuum.
[2] Twenty-two hours in vacuum oven at 65° C. and 20–26 in. vacuum.
[3] Twenty-two hours in vacuum oven at 60° C. and 20–26 in. vacuum.
[4] Two hundred grams raw sweet potatoes were used.
[5] Fifty grams of dehydrated dice were used. Dehydrated dice were not stored but were prepared from stored raw roots as outlined.

However total solids (Table 1, column 6) obtained by gravimetric measurements of the residues from ethanol extraction and the recovered alcohol solubles (both corrected for moisture content) exhibited a marked decline after curing (10 days from time of harvest), a greater decrease after the first month of storage at 60° F., but very little change after 4 months and even 6 months of storage. The dried residue after alcohol extraction (comprising the bulk of the solids) also showed a continuing decline with curing and storage (Table 1, column 4). On the other hand the alcohol solubles decreased slightly with curing but increased regularly with storage up to 6 months (Table 1, column 5).

In the dehydrated products, calculated total solids (Table 1, column 3) based on moisture determinations seemed not to vary regardless of the changing storage conditions of the raw roots. Gravimetric determinations for total solids (Table 1, column 6) showed a drop between the first and fourth months of storage and a leveling off until the sixth month. Similarly

TABLE 2

Effects of curing, storage and dehydration on the sugars, starches and sugar-free alcohol solubles in raw sweet potatoes and their dehydrated products

Storage of raw materials	Per cent total solids[1]	Weight of sugars in alcohol solubles[4]	Sugars as per cent total solids	Weight of starch	Starch as per cent total solids	Weight of sugar-free alcohol solubles[5]	Sugar-free alcohol solubles as per cent total solids	Total per cent of solids accounted for
Raw[2]								
	%	g.	%	g.	%	g.	%	%
0 days (fresh)	32.91	12.48	18.96	39.54	60.06	2.12	3.22	82.24
10 days (cured) 60° F.	31.21	12.13	19.43	37.95	60.80	1.73	2.77	83.00
1 mo.	28.81	11.90	20.65	32.78	56.89	2.12	3.68	81.22
4 mo.	28.39	13.33	23.48	29.90	52.66	2.06	3.63	79.77
6 mo.	28.10	14.93	26.56	26.02	46.30	2.24	3.99	76.85
Dehydrated[3]								
0 days (fresh)	93.52	24.62	52.65	5.74	12.28	1.15	2.10	67.03
10 days (cured) 60° F.	93.82	24.34	51.89	7.80	16.63	0.62	1.21	69.73
1 mo.	95.74	21.04	43.89	5.07	10.59	5.52	11.53	66.01
4 mo.	88.30	23.97	54.29	2.66	6.02	4.62	10.46	70.77
6 mo.	91.72	26.20	57.13	2.32	5.06	3.57	7.54	69.73

[1] Based on experimentally determined solids.
[2] Two hundred grams of raw sweet potatoes were used.
[3] Fifty grams of dehydrated dice were used. Dehydrated dice were not stored but were prepared from the stored raw roots as outlined.
[4] Deionized, freeze-dried and dried over P_2O_5.
[5] By difference.

a decided drop in the residue from ethanol extraction (Table 1, column 4) occurred between the first and fourth months of storage followed by a leveling off until the sixth month of storage. The dried alcohol solubles (Table 1, column 5) followed the same pattern as those of the raw samples from which they were processed, i.e., they increased regularly with storage.

Sugars in the raw roots, calculated as per cent of total solids (Table 2, column 4), exhibited a continuing increase with curing and storage up to 6 months. Starch did not change with curing (Table 2, column 6) but decreased markedly with storage. There appeared to be no great changes in the sugar-free alcohol solubles (Tables 2, column 8).

Sugars (Table 2, column 4) in the dehydrated product made from raw roots stored for 1 month were considerably lower than in dice prepared from freshly harvested or cured roots. Concentrations of sugars in dice processed from roots stored 4 and 6 months were higher than that found in dice made from freshly harvested roots. Starch (Table 2, column 6), on the other hand, was higher in dehydrated dice prepared from cured roots than in dice from freshly harvested roots. However, the concentrations of starch in the dehydrated products were lower the longer the roots remained in storage. The sugar-free alcohol solubles (Table 2, column 8) were much higher in the dehydrated product made from roots stored for 1 month than in those made from freshly harvested or cured roots. Sugar-free alcohol solubles decreased slightly in the dehydrated products made from roots stored 4 and 6 months, the high values remained relatively high.

Great changes took place in the quantities of total sugars, starch, and alcohol solubles as a result of dehydration (Table 3). There was more than a 2-fold increase in total sugars in the dehydrated products (Table 3, column 4). The value remained fairly constant regardless of the storage conditions of the raw roots from which the dice were processed. Starch, on the other hand, was 3.5 to 9 times lower depending on the conditions of storage of the raw material (Table 3, column 7). Less starch was degraded during dehydration of the cured sweet potatoes than during dehydration of the freshly harvested roots or those stored for 1 to 6 months. As the time interval of storage of the raw roots at 60° F. increased, the quantity of starch degraded during dehydration also increased. Sugar-free alcohol solubles (Table 3, column 10) were lower in dehydrated products made from freshly harvested and cured roots than in the raw roots themselves. However, sugar-free alcohol solubles were from 2 to 3 times higher in the dehydrated products made from stored roots. The maximum occurred in dehydrated dice made from roots that had been stored for 1 month.

Changes in the distribution of the simple mono- and disaccharides and inositol with curing and storage of the raw potatoes are outlined in Table 4. Inositol was included with the sugars because it was isolated with them during deionization and was present in measurable quantities. Sugars extracted from the raw roots contained a major percentage of sucrose ranging from 66 to 75% (Table 4, column 3); minor percentages of glucose and fructose ranging from 7 to 11% and 6 to 11% respectively (Table 4, columns 4 and 5 respectively); and only small quantities of maltose, 2.7 to 4.0% (Table 4, column 2). From a practical viewpoint the concentration of maltose seems to be rather constant throughout curing and storing of the roots. After the curing period, the quantities of sucrose, glucose, and fructose were higher, significantly so for the last 2 named as compared with those found in the freshly harvested roots

TABLE 3

Effect of dehydration on the distribution of total sugars and starches in Unit I Porto Rico sweet potatoes

Storage of raw materials	Sugars as per cent total solids in		Gain in sugar % dehydrated	Starch as per cent total solids in		Loss in starch % raw	Sugar-free alcohol solubles as per cent total solids in		Loss or gain in sugar-free alcohol solubles
	Raw sweet potato[1]	Dehydrated dice[2]	% raw	Raw sweet potato[1]	Dehydrated dice[2]	% dehydrated	Raw sweet potato[1]	Dehydrated dice[2]	% dehydrated % raw
	%	%		%	%		%	%	
0 days (fresh)	18.96	52.65	2.78	60.06	12.28	4.89	3.22	2.10	0.65
10 days (cured) 60° F.	19.43	51.89	2.67	60.80	16.63	3.66	2.77	1.21	0.44
1 mo.	20.65	43.89	2.13	56.89	10.59	5.37	3.68	11.53	3.13
4 mo.	23.48	54.29	2.31	52.66	6.02	8.75	3.63	10.46	2.88
6 mo.	26.56	57.13	2.15	46.30	5.06	9.15	3.99	7.54	1.87

[1] From 200 g. of raw sweet potatoes. Values converted to a dry basis.
[2] From 50 g. of dehydrated product. Values converted to a dry basis. Dehydrated dice were not stored but were prepared from the stored raw roots as outlined.

TABLE 4

Effect of storage and dehydration on the distribution[1] of the individual sugars and inositol in sweet potatoes

Storage conditions	Sugars and inositol					Total sugars and inositol accounted for
	Maltose	Sucrose	Glucose	Fructose	Inositol[2]	
Raw[3]						
	%	%	%	%	%	%
0 days (fresh)	3.64	73.44	8.74	7.10	trace	92.33
10 days (cured) 60° F.	4.00[5]	75.40	9.69[5]	8.88[5]	2.34	99.85
1 mo.	2.72[5]	67.60[5]	6.80[5]	5.89[5]	8.48	91.40
4 mo.	3.20[5]	72.37	8.19	7.07	3.09	93.92
6 mo.	2.81[5]	65.83[5]	10.57[5]	10.41[5]	2.24	92.60
Dehydrated[4]						
0 days (fresh)	59.70	23.68	2.58	2.23	4.73	92.92
10 days (cured) 60° F.	53.53[5]	22.94	3.55[5]	2.51[5]	6.60	89.03
1 mo.	51.97[5]	24.35	3.88[5]	2.53[5]	2.69	85.50
4 mo.	54.48[5]	27.26[5]	5.70[5]	4.52[5]	3.55	95.77
6 mo.	50.64[5]	31.57[5]	5.76[5]	4.39[5]	0.78	93.34

[1] Chromatographic separation and elution of the various components which were then determined with anthrone. Each value is the average of 4 individual determinations, each determination being the average of duplicates.

[2] Determined by the periodate method of Platt and Glock *(39)*. The quantities of inositol were so small that the 4 replicates were combined for 1 titration.

[3] Two hundred grams of raw sweet potatoes were used.

[4] Fifty grams of dehydrated dice were used. Dice were prepared from stored raw roots as outlined.

[5] Significantly different from "fresh" at the 0.05 level by analysis of variance and Duncan's Multiple Range Test *(11)*.

(Table 4, columns 3, 4 and 5, respectively). By the end of the first month of storage, however, there was considerably less sucrose, glucose and fructose than had been found in the freshly harvested material. There were significant increases in the concentrations of glucose and fructose at the end of 6 months of storage at 60° F. During the 6-month storage interval, inositol increased from a trace at harvesting to the second highest component in concentration after 1 month of storage and then decreased again (Table 4, column 6).

In the dehydrated products made from the above raw sweet potatoes, maltose was present in the greatest quantity, 51 to 60% (Table 4, column 2); sucrose in moderate concentration, 23 to 32% (Table 4, column 3); glucose, fructose and inosital in minor quantities, 2.6 to 5.8%, 2.2 to 4.5%, and 0.78 to 6.6% respectively (Table 4, columns 4, 5, and 6). In addition to the overall effect of dehydration, there is observed also the effect of the condition of the raw material at the time of dehydration on the distribution of the individual sugars. For instance, there is considerably less maltose (Table 4, column 2) in the dehydrated dice made from cured roots than in the dice made from freshly harvested roots. Not much change occurs in the quantities of maltose in the dehydrated products made from stored roots until the roots have been stored 6 months. Then another noticeable drop occurs in the maltose content of the dehydrated dice. The concentrations of sucrose, glucose and fructose (Table 4, columns 3, 4, 5) are higher in the dehydrated products made from stored raw roots than in those made from freshly harvested and cured roots. The concentration of inositol (Table 4, column 6) is higher in the dehydrated product made from cured roots than in the product made from freshly harvested roots. Dehydrated products made from stored roots contained much lower quantities of inositol.

To get a clearer estimation of the changes occurring in the distribution of the individual sugars during dehydration, gains (+) or losses (−) in the percentages of sugars are outlined in Table 5. There are gains in maltose content of 48 to 56%; losses in sucrose, glucose and fructose of 34 to 52%, 2 to 6.1%, and 2 to 6.4% respectively; and losses in inositol of almost 6% to gains of nearly 5%. It would appear from the data outlined in Table 5 that during dehydration of the cured and stored roots similar quantities of maltose (Table 5, column 2) are produced; that the maximum quantity of sucrose (Table 5, column 3) disappears during dehydration of the cured roots, that the least glucose and fructose (Table 5, columns 4 and 5) disappear during dehydration of roots stored for 1 to 4 months; that considerable quantities of inositol (Table 5, column 6) are produced during dehydration of the freshly harvested and cured roots, and that even more inositol disappears during dehydration of roots stored for 1 month. The last column of Table 5 shows that during dehydration there is a net gain in sugars in the products made from roots stored for 4 and 6 months.

TABLE 5

Percentages of individual carbohydrates lost or gained during dehydration

	Maltose	Sucrose	Glucose	Fructose	Inositol	Net effect
	%	%	%	%	%	%
0 days (fresh)	+56.06	−49.76	−6.16	−4.87	+4.73	0.00
10 days (cured) 60° F.	+49.53	−52.46	−6.14	−6.37	+4.26	−11.18
1 mo.	+49.25	−43.25	−2.92	−3.36	−5.79	−6.07
4 mo.	+51.28	−45.11	−2.49	−2.55	+0.46	+1.59
6 mo.	+47.83	−34.26	−4.81	−6.02	−1.46	+1.28

DISCUSSION

Qualitative and quantitative results with deionized alcohol-soluble constituents of the sweet potato essentially confirm observations made previously on changes occurring during curing and storage of the raw roots. The quantities of starch and total sugars are slightly higher after the roots have been cured *(6, 25)*. When put into storage at 60° F., a temperature that is 25° F. lower than that of curing, changes take place in the sweet potato that are reflected in the starch and sugar contents. There is successively less starch *(25)* in roots stored for 1, 4, and 6 months counterbalanced by increasing amounts of total sugars. Individually, there is less sucrose, glucose and fructose counterbalanced by a marked increase in inositol in the initial month of storage. After 4 months of storage at 60° F., the relationship between quantities of sucrose, glucose and fructose in the roots is similar to that found immediately after harvest. When examined statistically, these values were not significantly different. Because of shrinkage brought about by loss of moisture and carbon dioxide, total sugars appear to have increased. At 6 months storage, this increase is marked, but the quantity of sucrose, the principal sugar, has declined considerably. The decline is overshadowed again by increases in both glucose and fructose. Apparently it is insufficient to determine changes only in nonreducing and reducing sugars. As has been shown the picture is considerably more complex. Even though it has been possible to quantitatively record changes, as a result of curing and storage in the principal sugars, trace quantities of other materials isolated with the sugars are known to be present but were not dealt with in this investigation and their impact on the distribution of the principal sugars is unknown.

Maltose has not heretofore been reported in the raw roots. The quantity found was relatively small and essentially constant. Too much significance cannot be attached to its presence because some maltose may have been formed during extraction of the sugars as sufficient heat was applied at that time.

For the first time, changes in concentrations of inositol are reported as affected by curing and storage of raw roots. At times the quantity of inositol exceeds that of glucose or fructose. Inositol increases from a trace at harvest, to a maximum after 1 month of storage. During that time sucrose goes through a maximum at curing which maximum precedes that of inositol. If there is an interdependent relationship between the 2 constituents it is not readily observed in this investigation. The presence of inositol in sweet potatoes probably confirms the presence of phytin *(4, 7)*. However, reports *(13, 14)* that inositol can be synthesized from glucose by the action of a plant cyclase should not be overlooked even though the presence of a cyclase in the sweet potato has not as yet been observed.

During dehydration many important changes took place. There is the possibility that some sucrose, glucose and fructose, but principally sucrose were leached out during peeling and/or blanching and sulfiting. In spite of this, less glucose and fructose disappeared from the dried dice processed from raw sweet potatoes that had been stored for 4 and 6 months. It is not known what happens to maltose during preparation for dehydration but it is probable that most of the maltose found in the dice develops during the dehydration process. Large quantities of starch and sucrose disappear during dehydration. How much depends on the quality of the raw material at the time of processing. Sugar-free alcohol solubles and inositol go through maxima that are dependent also on the quality of the raw material at the time of dehydration.

While apparently some sucrose, glucose and fructose were produced as a result of curing the raw roots and maltose was produced during dehydration confirming the findings of other investigators *(6, 9, 21, 48)*, the mechanism by which these sugars have been formed is still in doubt. Early reports of an amylase in sweet potatoes and of its isolation were made by Giri *(16, 17, 18)* and Johnstone *(26)*. Bois and Savary *(8)* have reported the presence of a maltogenic or β-amylase, a sucrogenic or α-amylase and invertase. They did not find any evidence of a maltase. Balls, Walden and Thompson *(5)* and Schwimmer *(40)* found large quantities of β-amylase in the sweet potato and only traces of α-amylase and maltase. The β-amylase seemed to be accompanied by considerable quantities of some carbohydrate and an acid phosphatase and was found to account for at least 60% of the starch breakdown *(5)*. Undoubtedly it is the β-amylase which causes the large increases in concentrations of maltose during dehydration. Similar increases in maltose during baking *(42)* and canning *(9, 48)* have been reported. Details of the dehydration process can be found in the publication of Arthur and McLemore *(2)*. There appears to be no evidence for the synthesis of starch during curing and storage of the raw roots.

SUMMARY

Chromatographic investigations are reported on the sugars in selected samples of raw sweet potatoes and their diced dehydrated counterparts — representing freshly harvested, cured, and 60° F. stored stock. Total sugars extracted from the raw roots contained a major percentage of sucrose ranging from 75% after curing to 66% at the end of 6 months of storage. With respect to the ranges for glucose (7–11%) and fructose (6–11%) the higher values were found in the stored stock. A small quantity of maltose (2.7–4.0%) was found, possibly an artifact. A trace of inositol observed in the freshly harvested sweet potatoes increased to a maximum after one month of storage and then decreased. In the dehydrated products made from the same raw stock, maltose made up 51 to 60% of the total sugars; sucrose 23 to 32%; and glucose, fructose and inositol smaller proportions (2.6–5.8%, 2.2–4.5% and 0.78–6.6% respectively). The quantities varied with the condition of the raw material used. The findings, in general, confirmed those of earlier workers.

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LITERATURE CITED

1. Albon, N., and Gross, D. The chromatographic determination of raffinose in raw sugars. *Analyst*, **77**, 410 (1952).
2. Arthur, J. C., Jr., McLemore, T. A., Miller, J. C., Jones, L. G., and Sistrunk, W. A. Sweet potato dehydration. Effects of conditions of storage of raw materials on chemical properties of dehydrated products. *J. Agr. Food Chem.*, **3**, 151 (1955).
3. Arthur, J. C., Jr., McLemore, T. A. Sweet potato dehydration. Effects of processing conditions and variety on properties of dehydrated products. *J. Agr. Food Chem.*, **3**, 782 (1955).
4. Averill, H. P., and King, C. G. The phytin content of foodstuffs. *J. Am. Chem. Soc.*, **48**, 724 (1926).
5. Balls, A. K., Walden, M. K., and Thompson, R. R. A crystalline β-amylase from sweet potatoes. *J. Biol. Chem.*, **173**, 9 (1948).
6. Barham, H. N., and Wagoner, J. A. Effect of time and conditions of cure on the carbohydrate composition of sweetpotatoes and the properties of their starches. *J. Agr. Research*, **73**, 255 (1946).
7. Bagaoisan, C. L. The phytin content of some Philippine food materials. *Philippine Agriculturist*, **21**, 53 (1932).
8. Bois, E., and Savary, J. Saccharases and sugars of *Ipomoea batatas* and of *Solanum Tuberosum*. *Can. J. Research*, **20B**, 195 (1942).
9. Culpepper, C. W., and Magoon, C. A. The relation of storage to the quality of sweet potatoes for canning purposes. *J. Agr. Research*, **33**, 627 (1926).
10. Dimler, R. J., Schaefer, W. C., Wise, C. S., and Rist, C. E. Quantitative paper chromatography of D-glucose and its oligosaccharides. *Anal. Chem.*, **24**, 1411 (1952).
11. Duncan, Daniel B. Multiple range and multiple F tests. *Biometrics*, **11**, 1 (1955).
12. Fairbairn, N. J. A modified anthrone reagent. *Chem. & Ind.* (London), **1953**, 86.
13. Fernández, O., Izquierdo, G., and Martinez, E. Biological origin of rubber-cyclases. Farm. nueva (Madrid), **9**, 563 (1944). *Chem. Abs.*, **40**, 4115 (1946).
14. Fernández, O., de Mingo, M., and Martinez, E. Cyelization of glucose. Farm. nueva (Madrid), **10**, 541 (1945). *Chem. Abs.*, **43**, 4229 (1949).
15. Gilman, H. *Organic Syntheses*. Collective Vol. 1, p. 60, J. Wiley & Sons, Inc., New York, N. Y., 1932.
16. Giri, K. V. Amylase from sweet potato (*Ipomoea batatas*). *J. Indian Chem. Soc.*, **11**, 339 (1934).

17. Giri, K. V. Chemical nature of amylases. The amylase of the sweet potato *(Ipomoea batatas)*. *Biochem. Z.*, **275**, 106 (1934).

18. Giri, K. V. Further studies on the hydrolysis of starch by sweetpotato amylase. *J. Indian Chem. Soc.*, **15**, 249 (1938).

19. Godin, P. A new spray reagent for paper chromatography of polyols and cetoses. *Nature*, **174**, 134 (1954).

20. Gore, H. C. Occurrence of disastase in the sweet potato in relation to the preparation of sweet potato syrup. *J. Biol. Chem.*, **44**, 19 (1920).

21. Gore, H. C. The formation of maltose in sweet potatoes on cooking. *Am. Food J.*, **18**, 519 (1923); *Ind. Eng. Chem.*, **15**, 938 (1923).

22. Hasselbring, H., and Hawkins, L. A. Physiological changes in sweet potatoes during storage. *J. Agr. Research*, **3**, 331 (1915).

23. Hasselbring, H., and Hawkins, L. A. Respiration experiments with sweet potatoes. *J. Agr. Research*, **5**, 509 (1915).

24. Helbert, J. R., and Brown, K. D. Factors influencing quantitative determination of methylpentoses and ketohexoses with anthrone. *Anal. Chem.*, **27**, 1791 (1955).

25. Hopkins, E. F., and Phillips, J. K. Temperature and starch-sugar change in sweet potatoes. *Science*, **86**, 523 (1937).

26. Johnstone, C. R. Physiological study of two varieties of *Ipomoea batatas*. *Botan. Gaz.*, **80**, 145 (1925).

27. Keitt, T. E. Sweet potato investigation. South Carolina Agr. Expt. Sta. *Bull.* **165** (1912).

28. Kirk, P. L., and Duggan, E. L. Biochemical analysis. *Anal. Chem.*, **26**, 163 (1954).

29. Koehler, L. H. Differentiation of carbohydrates by anthrone reaction rate and color intensity. *Anal. Chem.*, **24**, 1576 (1952).

30. Koyanagi, T., and Matui, H. Nutritional chemistry of sweet potatoes. I. A new treatment of sweet potatoes. Kagaku noRyôiki (J. Japan Chem.), **1**, 65 (1947). *Chem. Abs.*, **44**, 3173 (1950).

31. Lambou, M. G. Sweet potato dehydration: Time and temperature of storage related to organoleptic evaluations. *Food Technol.*, **10**, 258 (1956).

32. Lambou, M. G., Lohmann, I. W., and O'Connor, R. T. Preparation and utility of color references for dehydrated sweetpotatoes. *Food Research*, **20**, 23 (1955).

33. Lambou, M. G. Multiple spray technique for locating sugars and polyols on the same chromatogram. *Anal. Chem.*, **28**, 1216 (1956).

34. Lambou, M. G. Mobilities of some polyols, sugars, acids and other compounds and their reactions on paper with the Godin Reagent. *Anal. Chem.*, **29**, 1449 (1957).

35. Magoon, C. A., and Culpepper, C. W. Scalding, precooking and chilling as preliminary canning operations. U. S. Dept. Agr., Dept. Bull. 1265 (1924).

36. Martin, A. J. P. The principles of chromatography. *Endeavour*, **6**, 21 (1947).

37. Miyake, K. On the nature of the sugars found in the tubers of sweet potatoes. *J. Biol. Chem.*, **21**, 503 (1915).

38. Morgan, N. D. A comparison of the freezing and alcohol method in the preservation of sweet potato samples for sugar determinations. *Proc. Am. Soc. Hort. Sci.*, **28**, 276 (1932).

39. Platt, B. S., and Glock, G. E. The estimation of inositol in animal tissues. *Biochem. J.*, **37**, 709 (1943).

40. Schwimmer, S. Sources of beta-amylase as supplements to barley malts in saccharification and fermentation. *Cereal Chem.*, **24**, 70 (1947).

41. Shiver, F. S. The determination of starch in the sweet potato. South Carolina Agr. Expt. Sta., *Bull.* 30 (1897).

42. Sistrunk, W. A., Miller, J. C., and Jones, L. G. Carbohydrate changes during storage and cooking of sweet potatoes. *Food Technol.*, **8**, 223 (1954).

43. Soloveichik, I. Y. Transformation of the carbohydrates of the sweet potato during culinary processes. *Voprosy Pitaniya*, **7**, No. 6, 138 (1938). *Chem. Abs.*, **35**, 5206 (1941).

44. Steiner, E. T., and Guthrie, J. D. Determination of starch in sweet potato products and other plant materials. *Ind. Eng. Chem., Anal. Ed.*, **16**, 736 (1944).

45. Stone, W. E. On the determination of carbohydrates of the sweet potato (Batatas edulis). *Ber. deut. Chem. Ges.*, **23**, 1406 (1890).

46. Tomita, K. The changes of chemical composition of sweet potatoes during the period of germination, growth, and preservation. III. The changes of chemical composition during preservation. *J. Fermentation Technol.* (Japan), **28**, 440 (1950).

47. Trevelyan, W. E., Procter, D. P., and Harrison, J. S. Detection of sugars on paper chromatograms. *Nature*, **166**, 444 (1950).

48. Wayley, J. F. Effect of storage on sweet potatoes in relation to canning. *The Crown*, 30, No. 2, 17 (1941).

49. Webb, R. E., Miller, J. C., and Edmond, J. B. Studies of total solids and sugar content in sweet potatoes. *Proc. Am. Soc. Hort. Sci.*, **54**, 403 (1949).

50. White, L. M., and Secor, G. E. Crystalline 2,4-dinitrophenylhydrazones of D-fructose. *J. Am. Chem. Soc.*, **75**, 6343 (1953).

51. White, L. M., and Secor, G. E. Microscopic identification of microgram quantities of D-fructose. *Anal. Chem.*, **27**, 1016 (1955).

52. Williams, K. T., and Bevenue, A. Qualitative paper chromatography of sugars in plants. *J. Assoc. Off. Agr. Chemists*, **36**, 969 (1953).

53. Woodroof, J. G., and Atkinson, I. S. Preserving sweet potatoes by freezing. Georgia Expt. Sta. *Bull.* 232 (1944).

Effects of Sodium Sorbate and Ascorbic Acid on Attempted Gamma Radiation Pasteurization of Apple Juice[a]

(Manuscript received September 7, 1957)

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RECENT INVESTIGATIONS by Salunkhe *(5)*, Ferguson and Powrie *(3)* and Weaver *et al. (6)* have shown that sorbic acid or sodium sorbate effectively prevented yeast fermentation in fresh unpasteurized apple juice. However, sorbic acid or sodium sorbate was ineffective in the control of *Acetobacter* which, in the presence of oxygen, caused deterioration of the juice in less than one week at room temperature. When air was excluded from the container, the addition of ascorbic acid, in conjunction with sorbic acid, delayed the development of *Acetobacter* and permitted storage of the juice at room temperature for a minimum period of two weeks with little loss of flavor or quality *(3)*.

Previous work *(4)* on the irradiation of apple juice was confined to observations on flavor and color after treatment with 300,000 to 1,000,000 rep. Although marked bleaching of the juice occurred at 300,000 rep, no serious alterations in flavor were observed with dosages up to 1,000,000 rep.

The present study was undertaken to determine if a low dosage radiation treatment could be used to inactivate *Acetobacter* so that the keeping time of fresh juice at room temperature could be extended.

MATERIALS AND METHODS

Fancy grade McIntosh and Toshkee apples, grown locally and stored for 6 months at 34° F. were thoroughly washed, ground in a grater mill, and pressed in a rack-and-cloth press with a pressure of 3000 p.s.i. After clarification with a pectin-decomposing enzyme (20 g. of Pectinol A per 10 litre of juice for 6 hours) the juice was filtered through nylon cloth in a plate and frame press filter.

One portion of the filtered juice was poured directly into a set of 21 clear glass, narrow neck bottles (200 ml.), previously sterilized in boiling water. Bottles were filled to capacity and closed tightly with sterilized plastic caps. To 3 other portions of the filtered juice was added sodium sorbate or ascorbic acid or both to obtain concentrations of 0.05% and 75 mg./100 ml., respectively, and subsequently 3 sets of 21 bottles were filled and capped as described. Another set of 21 bottles was partially filled with only 100 ml. juice containing both sodium sorbate (0.05%) and ascorbic acid (75 mg./100 ml.).

A total of 35 bottles, 7 from each of the 5 lots mentioned above, was distributed randomly into each of 3 irradiation containers which were then transported to the fuel rod gamma irradiation facilities at Chalk River, Ontario. The 3 standard containers were exposed alternately for 2, 5 or 9 hours, respectively, to an average field of 69,000 rep/hr. with a maximum variation of 25% throughout the irradiation box. The time lapse between the pressing of the juice and the arrival of the samples at Chalk River for irradiation treatment was approximately 10 hours. An additional 16 hours was required to complete irradiation of all samples. Control samples of each treatment were held under comparable storage conditions (room temperature) at Ottawa for a similar period before the initial analyses. The change in chemical and microbial content as a result of this holding period was small due to the extreme sanitary precautions taken in preparing and bottling the samples. For instance, 26 hours after pressing total number of microbes per ml. juice of the control samples was not more than 1300.

After the irradiation treatment containers were returned directly to Ottawa and stored at 70° F. Individual bottles of juice were analyzed at regular intervals for flavor, color, viscosity, pectinolytic enzyme activity, total acidity, pH, ascorbic acid, and microbial composition by the following methods:

Flavor of juices was evaluated by a 3-member taste panel scoring flavor on a hedonic scale of 1 to 5 and off-flavor as either absent or present.

Color changes were determined in a Klett-Summerson photoelectric colorimeter with No. 42 Blue and 54 Green filters, using distilled water for the zero settting.

Relative viscosity of the samples was calculated from the ratio of the time of juice flow to the time of distilled water flow at 72° F. using a 25 ml. pipette.

Pectinolytic enzyme activity was measured according to the method of Bell and Etchells *(2)* using an Oswald-Fenske pipette and a 1.2% sodium polypectate solution at 85° F.

Total acidity (as per cent malic acid) was determined by titrating 10 ml. of the juice with 0.1 N NaOH solution, using phenolphthalein as an indicator.

pH values of the juices were measured with a Beckman Model G pH meter.

Ascorbic acid was estimated by the 2,6-dichlorophenolindophenol titration method *(1)*.

Microbial content was determined by plating aliquots of the juices on Difco malt agar of pH 5.5.

RESULTS AND DISCUSSION

Irradiation at all 3 levels caused considerable browning of the glass bottles, the effect being more intense at 621,000 rep than at 344,000 or 138,000 rep. The brown, opaque appearance faded only slightly during 60 days of observation.

Flavor scores (Table 1) indicate the severe effect of all irradiation dosages, regardless of the pre-treatment. Only the samples which scored 11 and 10 can be considered acceptable. None of the samples had the original apple flavor or aroma, but instead had a strong "cooked flavor," which was more pronounced

[a] Contribution No. 906, Horticulture Division, Experimental Farms Service, Ottawa, and No 444, Bacteriology Division, Science Service, Ottawa.

TABLE 1

Flavor scores of apple juice after gamma irradiation [1, 2]

Days after irrad.	Dos. rep x 10^3	Pre-treatments				
		Sodium sorbate 0.05%	Ascorbic acid 75 mg./100 ml.	Sodium sorbate (0.05%) and ascorbic acid (75 mg./100 ml.)		No pre-treatment
				Full bottle	Half bottle	
2	138	11	6	5	10	8
	344	5	9	6	9	6
	621	5	6	5	6	8
7	138	7	7	8	3	3
	344	6	7	7	7	4
	621	5	5	6	3	5
13	138	4	1	4	1	2
	344	4	3	2	2	5
	621	3	3	2	2	4

[1] Maximum score 15.

[2] The not irradiated juice, immediately after preparation, rated 12 irrespective of pre-treatment.

at 621,000 rep. After 7 days, all samples irradiated with 138,000 and 344,000 rep, except those containing both sodium sorbate and ascorbic acid, had developed a typical vinegar flavor. After 13 days the samples treated with 621,000 rep showed a similar result. Results of the determinations on the microbial composition (Table 2) run parallel with these observations.

TABLE 2

Microbial content of apple juice after gamma irradiation [1, 2]

Days after irrad.	Dos. rep x 10^3	Pre-treatments				
		Sodium sorbate 0.05%	Ascorbic acid 75 mg./100 ml.	Sodium sorbate (0.05%) Ascorbic acid (75 mg./100 ml.)		No pre-treatment
				Full bottle	Half bottle	
2	138	1,060	76	40	450	10,000
	344	<10	14	72	240	15,000
	621	11	16	<10	<10	8,500
7	138	15,000	1,900	<10	40,000	300,000
	344	200	37	<10	40,000	200,000
	621	<10	<10	<10	200	16,000
13	138	3,000,000	980,000	3,000,000	3,000,000	3,000,000
	344	72,000*	30,000*	<10	200,000	8,600*
	621	11	50,000*	<10	4,000,000	5,000*

* Mainly molds.

[1] Results expressed as total number of microbes per ml. juice.

[2] Total number of microbes per ml. juice at time of irradiation, 1,000–1,300.

These results indicate that the apple juice was not completely sterile after irradiation with 138,000 to 621,000 rep. In the present experiments addition of sodium sorbate plus ascorbic acid prevented microbial development up to 13 days at all levels of irradiation. However, similar results can be obtained without radiation treatment as indicated by the work of Ferguson and Powrie *(3)*. Addition of sodium sorbate plus irradiation with 621,000 rep also prevented microbial development, but after irradiation at 138,000 or 344,000 rep this inhibition was less pronounced. However, Ferguson and Powrie *(3)* found practically complete inhibition of yeast and mold growth in non-irradiated apple juice treated with 0.035% sorbic acid. It is suggested that the free radicals formed during irradiation combined with the sorbic acid, and thus interfered with the activity of this compound. In the presence of ascorbic acid, the activity of the sodium sorbate was maintained presumably because the free radicals combined more readily with ascorbic acid.

Changes in the ascorbic acid concentration of the juice samples, fortified with 75 mg. ascorbic acid per 100 ml. prior to irradiation, are presented in Table 3.

TABLE 3

Changes in the ascorbic acid content of apple juice after gamma irradiation [1]

Days after irrad.	Dos. rep x 10^3	Pre-treatments		
		Ascorbic acid 75 mg./100 ml.	Sodium sorbate (0.05%) and ascorbic acid (75 mg./100 ml.)	
			Full bottle	Half bottle
2	138	68.8	68.2	36.5
	344	65.9	65.9	42.0
	621	67.2	67.0	42.0
7	138	67.9	67.8	17.7
	344	62.8	67.3	11.2
	621	63.8	63.8	6.1
13	138	60.9	60.5	9.3
	344	56.3	52.1	2.1
	621	53.8	49.2	0

[1] Results expressed as mg. ascorbic acid/100 ml.

Greater losses of ascorbic acid are shown at the higher irradiation levels, especially after 7 and 13 days. Ascorbic acid losses are considerably larger in bottles which were only half filled and again higher levels of irradiation caused greater losses. Possibly the formation of free radicals during irradiation at higher levels is responsible for this more rapid destruction, although more rapid destruction could also result from the direct action of the higher irradiation dosages.

Table 4 shows the results of determinations on the pectinolytic enzyme activity and relative viscosity of juice samples before and after irradiation with 621,000 rep. Similar results were obtained after irradiation at 138,000 and 344,000 rep. The results indicate that the activity of pectinolytic enzymes has not been altered and apparently higher dosages of radiation are necessary to inactivate these enzymes.

TABLE 4

Effect of gamma irradiation (621,000 rep) on the pectinolytic enzyme activity and relative viscosity of apple juice

Pre-treatments	Before irradiation		Days after irradiation			
			Two		Seven	
	Pect. enzyme activity [1]	Relative viscosity	Pect. enzyme activity	Relative viscosity	Pect. enzyme activity	Relative viscosity
Sodium sorbate (0.05%)	97	2.06	94	2.06	95	1.72
Ascorbic acid (75 mg./100 ml.)	95	1.76	95	1.84	96	1.47
Sodium sorbate (0.05%) plus ascorbic acid (75 mg./100 ml.)	95	2.23	96	1.84	96	1.52
No pre-treatment	94	1.92	95	1.81	96	1.61

[1] Results expressed as per cent loss of viscosity of the standard polypectate solution after addition of the apple juice.

TABLE 5

Effect of gamma irradiation on the pH and total acidity of apple juice

Irrad. dos. and pre-treatment	Before irradiation		Days after irradiation					
			Two		Seven		Thirteen	
	pH	Acidity[1]	pH	Acidity	pH	Acidity	pH	Acidity
138,000 rep sodium sorbate (0.05%) + ascorbic acid (75 mg./100 ml.)	3.42	.710	3.51	.724	3.51	.750	3.61	.737
344,000 rep sodium sorbate (0.05%) + ascorbic acid (75 mg./100 ml.)	3.42	.710	3.51	.697	3.60	.757	3.64	.757
621,000 rep sodium sorbate (0.05%)	3.45	.690	3.41	.697	3.56	.710	3.61	.717
621,000 rep sodium sorbate (0.05%) + ascorbic acid (75 mg./100 ml.)	3.42	.710	3.50	.717	3.65	.757	3.68	.757

[1] Expressed as per cent malic acid.

TABLE 6

Effect of gamma irradiation on the color of apple juice

Irrad. dos. and pre-treatment	Light absorption—colorimeter reading							
	Before irradiation		Days after irradiation					
			Two		Seven		Thirteen	
	42 Blue	54 Green	42 Blue	54 Green	42 Blue	54 Green	42 Blue	54 Green
138,000 rep sodium sorbate (0.05%) + ascorbic acid (75 mg./100 ml.)	188	43	125	24	128	23	133	26
344,000 rep sodium sorbate (0.05%) + ascorbic acid (75 mg./100 ml.)	188	43	109	22	118	23	120	24
621,000 rep sodium sorbate	231	62	119	25	143	38	159	48
621,000 rep sodium sorbate (0.05%) + ascorbic acid (75 mg./100 ml.)	188	43	96	14	113	23	127	22

The decrease in viscosity observed as a result of pectinolytic enzyme activity after 7 days could be noticed organoleptically and contributed to lower acceptability ratings by the taste panel. Since the microbial development in the samples irradiated at 621,000 rep and stored for 7 days, is still very small (Table 2), the possible interference of enzymatic activity contributed by micro-organisms can be ruled out. On the other hand, the progressive breakdown of ascorbic acid, reported in Table 3, might have been caused by the direct enzymatic and chemical activity of the juice.

Tables 5 and 6 summarize representative data on changes in pH, total acidity and color. These data were obtained from samples which were free of microbial development up to the 13th day after irradiation. Results indicate no difference in effects at the various levels of irradiation with respect to changes in pH or acidity. Samples treated with sodium sorbate only have a slightly lower pH and a corresponding higher acidity but the difference is of little significance.

Changes in color are more pronounced in the amber-yellow region and more bleaching of the color occurred at the higher levels of irradiation. After 2, 7 and 13 days, however, a gradual return to the original color was observed, although the color intensity did not equal that of juice before irradiation.

CONCLUSIONS

Irradiation of apple juice at 621,000 rep or lower does not produce sterile juice. After irradiation at 621,000 rep in the presence of sodium sorbate (0.05%) and ascorbic acid (75 mg./100 ml.), the juices can be kept at room temperature for thirteen days without the development of micro-organisms. However, alterations in flavor, viscosity and color seriously reduce the quality and acceptability of the juice.

LITERATURE CITED

1. Association of Vitamin Chemists. *Methods of Vitamin Assay*. 1951. Interscience Publishers, Inc., New York, N. Y.
2. Bell, T. A., and Etchells, J. L. A method for testing cucumber salt-stock brine for softening. U.S.D.A. Southern Utilization Research Branch (1955).
3. Ferguson, W. E., and Powrie, W. D. Studies on the preservation of fresh apple juice with sorbic acid. *App. Microb.*, **5**, 41 (1957).
4. Morgan, B. H. Food irradiation round-up. *Food Eng.*, 27, 43 (1955).
5. Salunkhe, D. K. Sorbic acid as a preservative for apple juice. *Food Technol.*, **9**, 590 (1955).
6. Weaver, E. A., Robinson, J. F., and Hills, C. H. Preservation of apple cider with sodium sorbate. *Food Technol.*, **11**, 667 (1957).

Factors Affecting Quality of Prepackaged Meat[a]

III. Chemical Tests Associated with Organoleptic Quality Factors Other Than Color[b]

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THE FOLLOWING ANALYSES were included in the chemical study of meats:

1. Free amino nitrogen of lean
2. Free acid value of lean
3. Peroxide value of fat
4. Free fatty acid value of fat
5. Iodine value of fat

EXPERIMENTAL

Free amino nitrogen and free acid of lean

To determine the free amino nitrogen and free acid of lean meat, a single sample was extracted according to the procedure described in the A.O.A.C. *Methods of Analysis (1)*. After Run S,[c] in order to increase both speed and accuracy, the method of extraction was modified as follows:

> Five grams of chopped sample were placed in a 500 ml. Erlenmeyer flask; 150 ml. of distilled water were added and the contents shaken vigorously for one minute. The sides of the flask were washed with 40 to 50 ml. of distilled water, and the flask was held at room temperature for one hour before making the analyses.

Free acid of sample was determined by titrating an aliquant of the prepared extract with standard sodium hydroxide solution to a phenolphthalein end point.

Free amino nitrogen of sample was determined on an aliquant of the extract using the Sorenson titration method *(1)*.

Peroxide value of fat

The method described by W. A. White *(5)* was used except for a modification in the procedure for removing final traces of ether from sample. Sample was extracted for 4 hours in a Soxhlet extractor with peroxide free ether. Heat was used to evaporate most of the ether from the sample and a vacuum at room temperature was used to remove final traces of ether.

A combination of the methods of C. H. Lea *(4)* and French, Olcott and Mattill *(2)* was used to obtain peroxide values. Extracted fat was dissolved in 20 ml. of a mixture (2:1) of glacial acetic acid and chloroform. About 1 g. of powdered potassium iodide was added under an atmosphere of nitrogen. The flask containing the mixture was stoppered with a rubber stopper which had a small hole in it. Mixture was kept at incipient boiling for 4 to 5 minutes on a water bath. It was cooled and titrated with standard sodium thiosulfate solution to a starch end point.

Free fatty acid of fat

Fat sample was placed in a beaker and rendered over boiling water. A weighed portion of the rendered fat was emulsified with neutralized alcohol by heating and shaking. Hot mixture was then titrated with standard sodium hydroxide solution to a phenolphthalein end point.

Iodine value of fat

A weighed portion of rendered fat was used for iodine value determinations. The method described by Hanus *(5)* was used.

RESULTS AND DISCUSSION

A. Chemical analyses. Chemical analyses were made on the samples which had been stored in various types of packages. Although ascorbic acid, N.D.G.A., or Achromobacter was added to some samples, most of the tests were conducted on the samples without chemical or biological additives. A list of the chemical tests is given in Table 1. Results of all tests using duplicate, triplicate, or quadruplicate samples are shown in Tables 2 to 6, inclusive. Because results of chemical tests on a single sample varied so widely, the value of individual tests was not sufficient to warrant listing all of them. However, some of these values are included.

Repeated experiments revealed that samples of meat from the same animal had different chemical values, and the chemical values varied for 2 different sections of the same sample. As would be expected, variation in chemical values of different sections of the same sample was usually smaller than that found in the chemical values of 2 different samples. This seemed to indicate that differences observed were not all due to inaccuracies in the methods.

Considering both the limitations of the methods of analysis and a statistical analysis of the results, it appears that the results of all chemical tests with the exception of those on the peroxide value, are reliable. Results of the peroxide value determinations should be used with reservation.

Free amino nitrogen of lean. During storage the free amino nitrogen of lean samples showed a tendency to increase. However, the increase was not pronounced or always consistent.

[a] A report of work conducted by contract with the Bureau of Animal Industry, U. S. Department of Agriculture, with funds provided under the Research and Marketing Act. The investigation is divided as follows: I. Physical and Organoleptic Studies. II. Color Studies. III. Chemical Studies. IV. Microbiological Studies.

[b] A paper of the Journal Series, N. J. Agricultural Experiment Station, Rutgers University, the State University of New Jersey, Departments of Food Technology and Animal Husbandry, New Brunswick, N. J.

[c] For a complete description of the various runs, see *Food Technol.*, 11, 277–284 (1957).

TABLE 1

List of chemical tests conducted in runs A–X

Run	Inoculated	% by wt. ascorbic acid added	% by wt. N.D.G.A. added	Peroxide (fat)	Fatty acid (fat)	Iodine (fat)	Free acid (lean)	Free amino N (lean)
A				x				x
B				x				x
C				x				x
D				x				x
E				x				x
F				x				x
G				x			x	x
H				x	x		x	x
I				x	x		x	x
J				x	x	x		
K					x		x	x
L					x		x	x
M								
N								
O				x	x	x		
P	x			x	x	x	x	x
Q				x	x	x	x	x
R				x	x		x	x
S	x			x	x		x	x
T		.1, .25			x		x	x
U		.1			x		x	x
V			.05		x		x	x
W							x	x
X							x	x
I					x			

TABLE 2

Results of peroxide determinations

Run	Type of meat	Storage ° F.	Number of replicates	Type of package	Chemical or biological additives	Averages of peroxide values — Days of storage										
						0	1	2	3-4	5-6	7-8	9-11	12-16	17-20	21-25	26+
J	Ground beef	34	4	can		1.2					7.9		52.5		16.	14.4
R	Ground lamb	40	1	can		0		0	.48		1.65	1.29	1.18			
R	Ground lamb	40	1	film 6d				0	0		1.6	1.07	3.24			
R	Ground lamb	40	1	film 15				0			2.18	.55	1.32			
S	Ground pork	40	1	can		a		1.6			6.8	5.	14.8			
S	Ground pork	40	1	film 6d				2.7	5.2		3.6	5.5	31.			
S	Ground pork	40	1	film 15				5.9	5.0		5.0	1.7	4.4			
S	Ground pork	40	1	can	Achromobacter			4.0	6.0		2.5		5.5			
S	Ground pork	40	1	film 6d	Achromobacter			5.5	4.9		5.9	0	14.3			
S	Ground pork	40	1	film 15	Achromobacter			7.3	4.7		2.9	0	13.7			

$$\text{Peroxide value of fat} = \frac{\text{Ml } Na_2S_2O_3 \times \text{Normality of } Na_2S_2O_3 \times 1000}{\text{Weight (grams) of fat}}$$

a—Initial values were not determined.

TABLE 3

Results of free fatty acid determinations

Run	Type of meat	Storage ° F.	Number of replicates	Type of package	Chemical or biological additives	Averages of free acid values of fat — Days of storage										
						0	1	2	3-4	5-6	7-8	9-11	12-16	17-20	21-25	26+
J	Ground beef	34	4	can		0					.2		2.8		3.4	3.8
U	Ground lamb	40	2	can		1.1		1.8	2.7		3.6	4.4	5.3			
U	Ground lamb	40	2	can	.1% ascorbic acid	1.1		2.2	2.7		3.8	4.7	5.7			
U	Ground lamb	40	2	film 15				2.0	2.7		3.7	4.7	5.7			
U	Ground lamb	40	2	film 15	.1% ascorbic acid			2.3	3.3		4.2	4.9	5.6			
U	Ground lamb	40	2	film 10				2.1	2.8		5.0	5.1	6.7			
U	Ground lamb	40	2	film 10	.1% ascorbic acid			2.2	3.2		4.0	4.3	6.2			
V	Ground lamb	40	2	can		1.0		1.5	1.5		2.3	2.8	3.9			
V	Ground lamb	40	2	can	.05% N.D.G.A.			1.5	1.4		2.3	2.9	3.6			
V	Ground lamb	40	2	film 15					1.6		2.3	3.0	3.7			
V	Ground lamb	40	2	film 15	.05% N.D.G.A.				1.7		2.4	3.3	4.0			
V	Ground lamb	40	2	film 10					1.6		2.3	2.8	3.7			
V	Ground lamb	40	2	film 10	.05% N.D.G.A.				1.7		2.5	3.6	3.8			

$$\text{fat} = \frac{\text{ml NaOH} \times \text{Normality of NaOH} \times 100}{\text{Weight (grams) of fat}}$$

Modification of method A.O.A.C. p. 301 (1945)

TABLE 4

Results of iodine value determinations

Run	Type of meat	Storage °F.	Number of replicates	Type of package	Chemical or biological additives	Averages of iodine values										
						Days of storage										
						0	1	2	3-4	5-6	7-8	9-11	12-16	17-20	21-25	26+
J	Ground beef	34	4	can		18				20			39		42	40
P	Ground lamb	34	1	can		43				45	42	45				
P	Ground lamb	34	4	can	Achromobacter					42	50	37				
P	Ground lamb	34	4	film 15						44	45	30				
P	Ground lamb	34	4	film 15	Achromobacter					43	41	32				
Q	Ground lamb	34	1	can		36						43	48		46	
Q	Ground lamb	34	1	film 6d								44	48		47	
Q	Ground lamb	34	1	film 6a								46	47		49	

Iodine value of fat = A.O.A.C.—Method of A.O.A.C. 494 (1945)

TABLE 5

Results of free amino nitrogen determinations

Run	Type of meat	Storage °F.	Number of replicates	Type of package	Chemical or biological additives	Average of free amino nitrogen values							
						Days of storage							
						0	1	2	3-4	5-6	7-8	9-11	12-16
U	Ground lamb	40	2	can	.1% ascorbic acid	a		7.1	7.2		9.0	9.7	9.9
U	Ground lamb	40	2	can				6.8	8.2		9.1	10.8	10.1
U	Ground lamb	40	2	film 15				7.1	7.3		9.1	9.6	10.5
U	Ground lamb	40	2	film 15	.1% ascorbic acid			6.5	7.6		8.5	9.3	9.7
U	Ground lamb	40	2	film 10				7.1	7.8		8.4	10.0	13.3
U	Ground lamb	40	2	film 10	.1% ascorbic acid				7.2		8.3	9.5	12.2
V	Ground lamb	40	2	can		7.5		9.1	11.6		11.1	11.9	11.1
V	Ground lamb	40	2	can	.05% N.D.G.A.			9.4	9.9		11.5	12.0	11.8
V	Ground lamb	40	2	film 15					10.3		10.9	11.9	12.6
V	Ground lamb	40	2	film 15	.05% N.D.G.A.				11.8		11.9	12.7	13.0
V	Ground lamb	40	2	film 10					9.7		11.9	12.3	13.0
V	Ground lamb	40	2	film 10	.05% N.D.G.A.				11.7		12.5	13.2	15.2
W	Cuts of beef	40	4	can		12.2	9.4	6.8	7.5	9.2	9.1		
W	Cuts of beef	40	4	film 15			8.9	8.5	7.5	7.9	8.6		
W	Cuts of beef	40	4	film 15 in desiccator			8.1	7.4	7.4	8.6	9.9		
X*	Cuts of beef	40	3	can		9.1	7.4	8.1	8.2	8.5	9.5		11.6
X*	Cuts of beef	40	3	film 15			8.3	8.8	8.5	8.8	9.7		11.0
X*	Cuts of beef	40	3	film 15 in desiccator			8.3	8.0	8.3	9.5	9.7		7.2

*The meat was frozen as chunks; then thawed before packaging.
a—Initial values were not determined.

TABLE 6

Results of free acid of lean determinations

Run	Type of meat	Storage °F.	Number of replicates	Type of package	Chemical or biological additives	Averages of free acid values of lean							
						Days of storage							
						0	1	2	3-4	5-6	7-8	9-11	12-16
U	Ground lamb	40	2	can		6.6		6.0	5.8		6.5	5.9	6.5
U	Ground lamb	40	2	can	.1% ascorbic acid			5.6	5.8		6.2	6.6	6.6
U	Ground lamb	40	2	film 15				6.1	6.2		6.3	6.6	6.4
U	Ground lamb	40	2	film 15	.1% ascorbic acid			5.7	6.4		6.1	6.5	6.5
U	Ground lamb	40	2	film 10				6.4	6.4		7.4	7.2	7.3
U	Ground lamb	40	2	film 10	.1% ascorbic acid				7.2		8.3	9.5	11.7
V	Ground lamb	40	2	can		5.2		5.9	5.9		6.2	6.7	6.3
V	Ground lamb	40	2	can	.05% N.D.G.A.			6.6	6.7		6.7	6.9	7.3
V	Ground lamb	40	2	film 15					6.6		6.7	6.7	7.7
V	Ground lamb	40	2	film 15	.05% N.D.G.A.				7.5		6.9	7.3	6.6
V	Ground lamb	40	2	film 10					6.5		6.8	7.3	6.5
V	Ground lamb	40	2	film 10	.05% N.D.G.A.				7.2		7.0	7.4	6.9
W	Cuts of beef	40	4	can		8.5	6.8	7.5	8.8	9.4	9.8		
W	Cuts of beef	40	4	film 15			8.4	8.5	8.8	9.8	9.1		
W	Cuts of beef	40	4	film 15 in desiccator			8.3	8.4	7.8	9.1	9.1		
X*	Cuts of beef	40	3	can		9.1	9.5	10.1	9.4	10.2	10.1		10.3
X*	Cuts of beef	40	3	film 15			9.9	10.2	10.1	10.7	10.3		10.4
X*	Cuts of beef	40	3	film 15 in desiccator			9.3	10.2	11.0	9.5	9.5		9.4

*The meat was frozen as chunks and then thawed before packaging.

$$\text{Free acid of lean} = \frac{\text{ml NaOH} \times \text{Normality of NaOH} \times 100}{\text{Weight (grams) of meat}}$$

Free acid of lean. Similarly, the free acid of lean usually increased slightly during storage. However, the rate of increase was not as great as the free amino nitrogen of lean.

Peroxide value of fat. Peroxide values of the fat followed a trend common to most fats and oils during storage. The induction period, which varied with the type of animal, temperature of storage, and type of package, was readily detectable by analysis. After the induction period, the peroxide value increased sharply. Rate of increase in peroxide value seemed dependent upon the oxygen permeability of the package.

Free fatty acid of fat. Rate of increase in the free acid of the fat was comparatively regular and varied both with meat type and storage temperature. A sharp increase in free acid was observed toward the end of a 21-day storage period at 40° F.

Iodine value of fat. No regular pattern of change was observed in iodine values during storage. Although the iodine values either decreased or increased, the variations were not consistent for any given set of conditions.

B. Correlation between chemical results and organoleptic results. Although color is of prime importance in the evaluation of organoleptic results, color cannot be readily related to the chemical results, because, under the packaging conditions of this experiment, the value of color does not decrease progressively during storage like other organoleptic factors of stored meat and like chemical values. Color value in vacuum packed samples in hermetic containers decreases to a minimum and then increases. This cycle of color change follows a more or less definite pattern.[d] The second maximum color value in non-cured meat is usually either higher than, or equal to, the original value.

Flavor is of great importance in the evaluation of organoleptic results. The odor of cooked and uncooked meat seems to follow a pattern similar to that of flavor. Thus organoleptic flavor results may be assumed to vary approximately as the total organoleptic, minus color, score.[e]

Table 7 shows the correlation between free fatty acid values and flavor scores of fat samples.

[d] A detailed discussion on the color of meat is found in Part II of this report.

[e] See discussion Part I-C.

[f] See Section 1-C, Tables 1 and 2 for flavor scores.

TABLE 7

Correlation: Free fatty acid vs. flavor

Run	Correlation factor	Significance
J	—.746	Significant
O	—.925	Highly significant
P	—.518	Not significant
Q	—.780	Highly significant
R	—.581	Not significant
S	—.874	Highly significant
T	—.754	Significant
U	—.479	Not significant

Correlation between values of free amino nitrogen of lean and flavor scores[f] of lean samples is shown in Table 8.

Factors listed in Table 7, in the investigators' opinion, indicate that, under the conditions of this study, there is a correlation between the free fatty acid of fat and the flavor score. Negative correlation means that as the free fatty acid of fat increases, the flavor score decreases. Factors listed in Table 8 indicate no correlation between the free amino nitrogen and flavor scores of lean.

TABLE 8

Run	Correlation factor	Significance
P	—.176	Not significant
Q	—.728	Highly significant
R	—.380	Not significant
S	Insufficient data	.....
T	—.760	Significant
U	—.810	Highly significant
V	—.230	Not significant
W	—.200	Not significant
X	—.711	Highly significant

Although correlations were not found between the other chemical values and the organoleptic scores of the samples, the following general statements may be made:

1. There is evidence that the flavor score of meat, in general, decreases when the chemical values of meat (results of 5 types of chemical tests used in this investigation) increase.

2. The flavor score of meat usually increases during the first 2 or 3 days of storage, which is probably due to the acquired taste habits of the judges. The flavor of unaged meat is often not as desirable as that of meat which has been aged. Therefore, for the first few days of storage (usually 3) preference of the judges for aged meat nullifies the statement that an increase in the chemical values of the samples correlates with a decrease in flavor scores.

Negative correlation between free fatty acid and flavor scores of fat samples is significant. Meat sold in stores usually contains about 25% fat *(3)*. "Fat" samples in this investigation contained approximately this percentage of fat. Therefore, the free fatty acid of the fat samples may be a good indicator of the quality of packaged meat.

All statements concerning the implication of the chemical results in respect to quality preservation of fresh meat were made without considering the color of the meat. Although color ratings were not considered in connection with chemical results, experiments in this project and information found in the literature indicate that changes in the chemical composition of meat, like the production of oxidizing agents (peroxide) or acids which result in pH changes, affect the rate of color change and the color itself.

C. Evaluation of the different packaging materials.

The following criteria were used in evaluating the packaging materials used for the meat in Runs A to X:

1. The chemical values which had shown correlation with the organoleptic results were used as one criterion. For example, any package that retarded the formation of free fatty acid was upgraded.
2. Chemical values obtained for meat which had been stored in a can (control sample) were used as the standard in all cases, including those in which the chemical values appeared to have no correlation with organoleptic results.

Table 9 gives a grading which indicates the overall results obtained for the various package types. (Refer to Tables 2–6).

TABLE 9

Overall results obtained for the packages used

Type of package	Number of runs	Days of storage	
		0-9	10-30
2			
3	10	I	
4a	1	S	S
6	6	S	S
6a	1	S	S
6d	3	B-S	I
8	1	S	I
10	3	S	I
15	14	S	S
16	2	S	S
17	1	I	I

Legend of grading symbols used in Table 9.
I = more chemical change than that obtained in can control.
S = chemical change approximately equal to that obtained in the can control.
B = less chemical change than that obtained in the can control.

The implication of the results obtained from the chemical analyses (shown in Tables 2–6) are as follows:

1. Chemical change in samples stored in films 4a, 6, 6a, 15 and 16 was practically equal to that of samples in the can.
2. Film 6d permitted equal or less chemical change than the can when the period of storage was less than 10 days.
3. Films 8 and 10 permitted equal chemical change to that in the can during the first week of storage at 40° F. After a week, very high chemical values appeared in those films.
4. For short periods (less than a week), film 6d gave the most satisfactory chemical results.
5. Observations not reflected in the entries in Table 9, except in the large number of determinations made, indicated that, for periods of storage longer than 10 days, film 15 gave most satisfactory chemical results.

SUMMARY

Free amino nitrogen, free acid of lean samples, peroxide value, free fatty acid and iodine value of fat samples were determined. A significant negative correlation between free fatty acid and flavor of fat samples was observed. Using the results of chemical analyses, performances of various films for packaging fresh meat were evaluated.

LITERATURE CITED

1. Association of Official Agricultural Chemists. *Official and Tentative Methods of Analysis.* 6th ed. 1945. Washington, D. C.
2. French, M. B., Olcott, H., and Mattill, K. F. *Ind. Eng. Chem.*, 27, 724–728 (1935).
3. Hankins, O. G. Bureau of Animal Ind., U. S. Dept. Agriculture (Personal communication).
4. Lea, C. H. *Rancidity in Edible Fats.* 1949. Chem. Publ. Co., Inc., New York, N. Y.
5. White, W. A. Methods for the investigation of rancidity and their inter-relation and application. *Can. J. Research*, 19D (1941).

Carotenoid Stability in Stored Dehydrated Carrots [a]

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THE NECESSITY for excluding oxygen from packs of dehydrated carrots has been repeatedly reaffirmed, and British reports issued early during World War II (see later publication *(5)*) placed a limit of 0.1 ml. oxygen per gram dehydrated carrot, at 5% moisture, if off-flavors were to be avoided. A reasonable carotene content for dried carrots is 1 mgm. per gram, and consequently for slightly less than 2 μmols of carotene, there should be, at the upper limit, not more than 4 to 5 μmols of oxygen. This seems surprisingly large, but carotene oxidation is avoided since oxygen is consumed in other reactions in the dehydrated food. However, this oxygen consumption is a function of the moisture content, and a progressive lowering of the moisture content from 5 to 2% or lower, could result in carotene oxidation at such a mol ratio of carotene to oxygen, particularly over a long period of storage.

The British reports *(5)* indicate that there was no loss of carotene in carrots after 6 months, in nitrogen, at 37° C., the highest temperature tested. However, losses were reported by Beardsley, Prindle and Stevens *(2)* Heberlein and Clifcorn *(3)* and others *(1, 4)*. Bailey *et al. (1)* reported a greater loss in carrots stored at 98° F. than in those stored at 120° F., a result not substantiated by Heberlein and Clifcorn *(3)*.

Perusal of the data presented by the above workers emphasizes one difficulty commented upon by Beardsley *et al. (2)*, the non-homogeneity present in some degree in most, if not in all of the vegetables tested.

In this paper we present evidence to show that samples may undergo severe browning without affecting the carotene, both in dehydrated carrots and in model systems of glucose, glycine and carotene, provided that oxygen has been excluded.

EXPERIMENTAL

Through the co-operation of members of the staffs of California Vegetable Concentrates and of the Folger Coffee Company, and with advice and assistance from Dr. D. H. Vosti of the American Can Company we packed 50 lbs. of conventionally dehydrated carrots, at 5% moisture, in 6¾ oz. Planters Peanut cans, or in 8 oz. coffee cans under the following conditions: air (atmospheric) and under vacuum, at 14, 22, 26, 28 and 29 in. Small samples were also sealed in glass ampoules at less than 1 mm. pressure. Reference samples were stored at 32° F., and the remainder at 104, 122 and 140° F. (i.e. 40, 50 and 60° C.). The last mentioned temperature, which might be deemed excessive, was chosen to ensure that considerable browning would occur. The carrots were then analyzed at periods of 0, 1, 2 and 3 months for carotenoid.

The dehydrated carrot dice were powdered in a Wiley mill, through a 20-mesh screen, and a 1 g. sample was hydrated and then completely extracted with acetone and petroleum ether. The extract was washed with water, dried over sodium sulfate and made to volume. The optical density was then determined from 500 to 320 mμ in a Beckman D. U. Spectrophotometer. An aliquot was isomerized with iodine and its absorption determined concurrently.

In view of the fact that the various extracts gave superimposable curves, from 500 to 400 mμ, as did the isomerized extracts, chromatographic checks were discontinued, and the total carotenoid calculated in terms of its β-carotene absorption equivalent. Results are shown in Table 1 for total carotenoid and in Figure 1 for the 2-month storage period under the different conditions of vacuum.

The carrot powders were measured for tristimulus Y by Angela C. Little for these samples on a Colormaster Differential Colorimeter. In Figure 2 the tristimulus Y is plotted as a function of time. For storage temperatures of 40 and 50° C., there was no significant difference in the browning, for vacuums varying from 14 to 29 in. At 60°, the results at 28 to 29 in. were outside the standard deviation, and the data are represented by 3 curves, instead of two.

[a] This study is based in part on research done under contract (now terminated) with the Quartermaster Food and Container Institute for the Armed Forces, Chicago, Illinois.

TABLE 1

Effect of vacuum on carotenoid retention—carotenoid content (mg. per gram dehydrated powder)

Time of storage (months)	Temperature of storage ° C.	Original vacuum						
		0	14	22	26	28	29	High [1] vacuum
0		1.400						
1	40	1.100	1.350	1.387	1.420	1.420	1.427	1.420
	50	1.160	1.315	1.378	1.465	1.425	1.435	1.430
	60	1.185	1.233	1.397	1.409	1.440	1.415	1.388
2	40	0.990	1.169	1.290	1.386	1.410	1.409	1.430
	50	1.070	1.159	1.240	1.370	1.395	1.385	1.440
	60	1.150	1.245	1.375	1.400	1.400	1.415	1.385
3	40	0.942	1.189	1.305	1.395	1.440	1.339	1.355
	50	1.060	1.165	1.280	1.371	1.379	1.355	1.400
	60	1.145	1.231	1.325		1.385	1.390	1.392

[1] Glass ampoules.

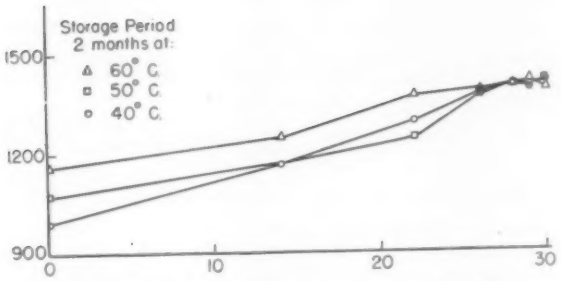


Figure 1. The effect of vacuum on carotenoid stability.

Note: Ordinate—Carotenoid in μg./gram.
Abscissa—Vacuum in inches.

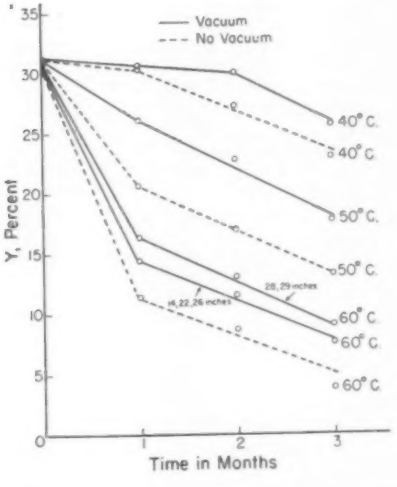


Figure 2. A measure of browning with time in carrots stored in air and under vacuum.

Note: The tristimulus Y is plotted as a function of time. For storage temperatures of 40 and 50° C., there was no significant difference in the browning, for vacuums varying from 14 to 29". At 60°, the results at 28 to 29" were outside the standard deviation, and the data are represented by three curves, instead of two.

In view of the foregoing results, it was considered possible[b] that the carotenoid *in situ* in the dehydrated carrot might be somewhat isolated and consequently protected from the reactants in the browning reaction. A series of test-tubes were therefore taken, and charged with *ca* 150 mg. of a 2:1 mixture, on a molar basis, of anhydrous glucose and glycine, intimately mixed after vacuum drying at 70° C. to constant weight. To each was then added 1 ml. of β-carotene in purified petroleum ether. The tubes were then placed in a vacuum desiccator over paraffin chips, and the solvent removed under vacuum. A vacuum should be pulled, and released 3 to 4 times to avoid an explosive vapor mixture on sealing. Half of the tubes were then sealed under vacuum, Cenco pump, below 1 mm., Series D.

The procedure adopted to avoid heating the sample was first to constrict the tube, then to place the sample at the bottom, using glazed paper to prevent particles adhering to the side; then to add the carotene and after evaporation of the solvent to draw out the tube at the point of constriction to a capillary, evacuate and seal.

These samples were then incubated at 40 and 60° C. The series, W, containing 0.5 ml. water, underwent severe browning, whereas the dry series, D, showed no visible indication of browning. Results are shown in Table 2.

TABLE 2

Carotene analyses in model systems under vacuum

Sample	Storage		Condition	Carotene (μg.)
	Days	Temperature ° C.		
Control	0	....	....	46.3
Dry	5	40	not brown	44.8
D	6	40	not brown	44.2
D	6	40	not brown	48.6
D	10	40	not brown	45.0
D	1	60	not brown	48.4
D	10	60	not brown	42.9
D	10	60	not brown	42.9
Wet	5	40	brown	45.1
W	5	40	brown	44.5
W	6	40	brown	46.9
W	6	40	brown	43.5
W	1	60	very brown	45.3
W	3	60	very brown	43.6
W	3	60	very brown	40.6
W	5	60	very brown	42.8

The question of analytical precision becomes all-important. The original solution of β-carotene contained *ca* 45 μg. per ml. This had to be diluted 1 to 10 or 1 to 25 for spectroscopic measurement, and this gave a value of 46.4. One ml. aliquots were added to the reaction mixture, sealed, re-opened without incubation, and on analysis gave values of 45.7, 49.2, and 43.8, average 46.2 ± 2.0 μg. per ml. To this must be added a further difficulty, the complete recovery from a very brown mixture.

When the data of Table 2 are averaged, the variation is within one measure of the standard deviation.

DISCUSSION

We believe that our procedure in the model system studies limited the errors to those inherent in the routine operations of pipetting, extraction and measurement. Precision is not gained by adding a weighed amount of carotene. Ten mg. could be weighed within a 1% weighing error, but such a quantity is far more difficult to handle in the extraction than are 50 μg. Furthermore additional dilution errors would be introduced.

Our data therefore support the view that anaerobic browning can be severe without affecting the carotene. On prolonged storage in the more acidic browned medium, cis-trans isomerization might be expected, but this has not yet occurred in our very brown samples, as shown in Figure 3, where curves are given for controls and for extracts from very brown samples, both for the original and iodine-catalyzed solutions.

Our data (Figure 1) also support the reversed temperature effect on carotene stability noted by Bailey *et al. (1)* if it be assumed that some oxygen was present in their samples. The explanation that reaction products are formed which inhibit carotene destruction at the higher temperature seems inherently less likely than the suggestion that other reactions in the carrot compete for the available limited supply of oxygen in the sealed container. The

[b] We are indebted to Professor M. A. Joslyn for suggestions on the model system experiments.

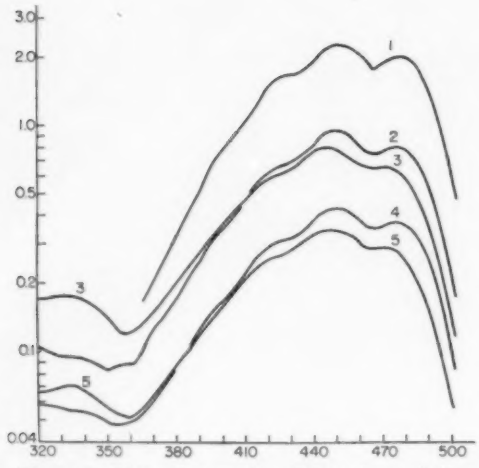


Figure 3. Absorption spectra of β-carotene solutions.

Note: Ordinate—Optical density in arbitrary units.
Abscissa—Wave length.
(1) Original.
(2) Stored 5 days 60° C., W, brown.
(4) Stored 10 days 60° C., D, not brown.
(3) and (5) Iodine catalyzed solutions of (2) and (4), respectively.

browning reaction has a high temperature coefficient, and a differential in rates would account for the higher carotene retention under lower vacuum. The breakpoint, *ca* 26 in., is valid at 5% moisture. As the moisture content is further reduced, it will be necessary in our view to attain a higher vacuum, such as is routinely achieved in packing coffee.

SUMMARY

Data are presented which show that in the absence of molecular oxygen, the carotenoids of dehydrated carrots and β-carotene in a glucose-glycine synthetic mixture are unaffected by severe browning.

LITERATURE CITED

1. Bailey, G. F., Dutton, H. J., Ambrose, A. M., Wilson, R. H., and DeEds, F. The content and biological availability of carotene in dehydrated carrots stored at high temperatures. *Arch. Biochem.*, **10**, 125–140 (1946).
2. Beardsley, C. L., Prindle, R. F., and Stevens, H. P. Retention of vitamins in dehydrated vegetables during storage. *Proc. Inst. Food Tech.*, 208–225 (1943).
3. Heberlein, D. G., and Clifcorn, L. E. Vitamin content of dehydrated foods. Effect of packaging and storage. *Ind. Eng. Chem.*, **36**, 912–917 (1944).
4. Research Dept. Continental Can Co. New facts about packaging and storing dehydrated foods. *Food Inds.*, 366–370, 417–419 (1944).
5. Tompkins, R. G., Mapson, L. W., Allen, R. J. L., Wager, H. G., and Barker, J. The drying of vegetables. III. The storage of dried vegetables. *J. Soc. Chem. Ind.*, **63**, 225–231 (1944).

Notes and Letters

Procedures for Conversion of Color Data from One System into Another

To satisfy the desire for objectivity in recording colors and to overcome the shortcomings of the human eye in color perception various instruments and devices have been constructed *(1)*. Some instruments answered a need; others exchanged one difficulty for another. As color recording became mechanized, the interpretation of the data became difficult. It is not simple to explain the desirable choice between x 0.480, y 0.355, Y 10 and x 0.475, y 0.360, Y 8 when the color of a red tomato is given in C.I.E. tristimulus values. The flesh of a French prune must be golden-yellow when ripe, and again the desirability of color value x 0.412, y 0.417, Y 43.06 in preference to x 0.391, y 0.391, Y 46.02 is not easy to see even for one familiar with the terminology.

Colorimeters and spectrophotometers are costly and for plant material may not give the desired answer directly. Some instruments require special preparation of the sample for recording of color. If the preparation is accompanied by a structural change, the recorded color may not be that of the original material. The recorded data will be valid and objective but will require correlation with standards that represent the color of the original material.

This problem confronted the Department in connection with establishing maturity standards of fruits. In order to better reconcile objective color measurements of fruit with the impression the eye receives, the values were recorded by visual comparison with color standards. Very good results can be obtained by visual color matching when the technician has a satisfactory color perception and is not overburdened with work. Two systems are available for visual comparison of colors—Maerz and Paul's Dictionary of Color and the Munsell Book of Color. For ease of direct matching colors Maerz and Paul's dictionary is preferable. It contains over 7000 colors in contrast to 421 or 982 (depending on the size of the book, i.e., library or pocket size) in the Munsell book. The disadvantage of the Maerz and Paul system is that the data cannot be treated mathematically—i.e., added and averaged. There is also no way of directly comparing the data with those in the C.I.E. system.

Since the fruit colors were recorded in Maerz and Paul system, it was necessary to convert them into Munsell system which can be treated mathematically. Except for a brief outline *(4)* there are no published details for converting color values from Maerz and Paul into Munsell, and the following procedure is based on personal communication *(8)*. The procedure for converting Munsell values into C.I.E. is not available in a lucid presentation in a single paper. The procedures described do not include all possible conditions, and the user may have to consult the literature in exceptional cases. For example, 4 samples of fruit were matched with the Maerz and Paul values shown in column 1 of the following table. The purpose is to obtain the average Munsell notation from which in turn, C.I.E. values may be calculated.

CONVERSION OF COLOR VALUES FROM MAERZ AND PAUL TO MUNSELL SYSTEM

1 *Maerz & Paul*	2 *Munsell*	3 *Numerical Hue notation*	4 *Product of Hue by Chroma*
11 L 4	4Y 7.3/7.0	24	168
12 L 3	5Y 6.2/5.0	25	125
12 L 1	10Y 6.8/7.0	30	210
12 K 7	10YR 5.7/5.5	20	110
Total	26.0/24.5		613
Average	6.5/6.1	and $\frac{613}{24.5} = 25$ (5Y), the average "Hue" value.	

Average Munsell notation 5Y 6.5/6.1.

1. Look up the equivalent of Maerz and Paul color values (11 L 4) column 1 in terms of Munsell in Nickerson, pp. 17–22 (7). On page 20 Maerz and Paul Plate 11, No. 4 under L, the value is 4Y 7.3/7.0.
2. The Munsell notation, column 2, line 1, is written in the following order: Hue 4Y, Value 7.3, and Chroma 7.0. Add "Value" and "Chroma" values, and take the average in the usual manner. In the above table the averages are 6.5/6.1.
3. The "Numerical Hue Notation", column 3, is derived as follows: In "Color Measurement and Its Application to the Grading of Agricultural Products", page 3, Figure 5, *(6)* the Hue value 4Y corresponds to the numerical value 24, 5Y = 25, 10Y = 30, and 10YR = 20, etc. Tabulate these values.
4. Average "Hue" by multiplying the "Numerical Hue Notation" values, column 3, by the corresponding "Chroma" in column 2. The product 24 x 7.0 = 168. Tabulate and add these products as in column 4.
5. To obtain the average "Hue" value, divide the sum of "Products of Hue by Chroma" column 4, 613, by the sum of "Chroma" from column 2, 24.5. From Figure 5, page 8, of the publication mentioned in Step 3, the corresponding Munsell Hue value is 5Y. The final recorded average Munsell value is 5Y 6.5/6.1.

Figure 5, page 8, of the publication *(6)* mentioned in step 3 is given only in part for illustrative purposes. If necessary, a complete chart can be redrawn by starting with 1R as 1 and filling in the numbers throughout the circle, ending with 10RP as 100.

THE C. I. E. SYSTEM

For special purposes, such as color work on fruit and vegetables, the Munsell color values may be ade-

quate, but for comparative purposes and correlation with instrumental values a precise definition of standard conditions may be required. As such the C.I.E. system is the accepted standard. Both Maerz and Paul and Munsell systems are visual standards that an observer can use for direct comparison of the sample with color chips. In the C.I.E. system the color of the sample is determined by an optical instrument; C.I.E. color chips are not generally available. The hue, saturation, and lightness are represented by numbers under standard conditions.

PROCEDURE FOR CONVERSION OF MUNSELL COLOR VALUES TO C. I. E. SYSTEM FOR ILLUMINANT C

Example: Munsell color 3Y 6.9/5.6
Terminology: 3Y – Hue
6.9 – Value
5.6 – Chroma

1. On the Munsell Hue and Chroma Value 6 *(3)*, locate trichromatic coefficients for Chroma 5.6 on the curve radiating from illuminant center, i.e., x = 0.415 and y = 0.408.
2. Since Value 6.9 is between 6 and 7, proceed as above using Hue and Chroma Chart Value 7, i.e., x = 0.402 and y = 0.399, and use the correction term 0.9 as shown below.
3. Calculate corrected values for x and y as follows:

Value 6	*Value 7*
x = 0.415	x = 0.402
y = 0.408	y = 0.399

$x_6 - x_7 = 0.415 - 0.402 = 0.013$
$0.9 \times 0.013 = 0.012$
$0.415 - 0.012 = 0.403$
$y_6 - y_7 = 0.408 - 0.399 = 0.009$
$0.9 \times 0.009 = 0.008$
$0.408 - 0.008 = 0.400$

Corrected values for chromaticity: x = 0.403 and y = 0.400

If the x and y values for the lower numerical order are smaller than for the higher, subtract the smaller value from the larger. Multiply as usual, but add the product to the smaller as in the following example.

	Value 6	*Value 7*
3 GY 6.8/6.3		
	x = 0.374	x = 0.384
	y = 0.447	y = 0.468

$x_7 - x_6 = 0.384 - 0.374 = 0.010$
$0.8 \times 0.010 = 0.008$
$0.374 + 0.008 = 0.382$
$y_7 - y_6 = 0.468 - 0.447 = 0.021$
$0.8 \times 0.021 = 0.017$
$0.447 - 0.017 = 0.464$

Corrected values for chromaticity:
x = 0.382 and y = 0.464

The above interpolation assumes linearity between two notations and that is not strictly true. However, the introduced error is of second order.

4. In table B *(5)* or table 1, page 11 *(6)*, look up Y for value 6.9, i.e., 41.63% luminous reflectance. Thus Munsell Color 3Y 6.9/5.6 in terms of C.I.E. is: x = 0.403, y = 0.400, and Y = 41.63% and 3 GY 6.8/6.3 is x = 0.382, y = 0.464, and Y = 40.23%.

The curves of loci of constant-hue and constant-chroma on the Hue and Chroma Value charts are divided into larger units than may be desirable. By drawing in fraction curves, the x and y values can be read with greater accuracy.

When only few conversions from Munsell to C.I.E. are required, the x and y values can be read directly from the chart. For processing a large number of data, it is advisable to construct tables for the desired Values and for the Hue range in which the data will be encountered. The construction of the tables introduces a small error since the tables imply a linear relationship, whereas the constant-hue and –chroma data are spaced on curves. The error will be constant for all data, and the tables have the advantage that an error is less likely to occur from their use than from reading the data from coordinates.

The C.I.E. data thus obtained do not give qualitative and quantitative color perceptibility differences, and for color work on food products and fruits the color spacing may be inadequate when precision work is required. Several systems have been designed to represent equal perceptible difference with equal increments. The MacAdam correlation has been used in many cases. This system expresses the color values on a uniform scale and permits direct comparison of widely separated colors which are not otherwise comparable. The use of MacAdam units also permits the comparison of total color as well as the chromaticity differences.

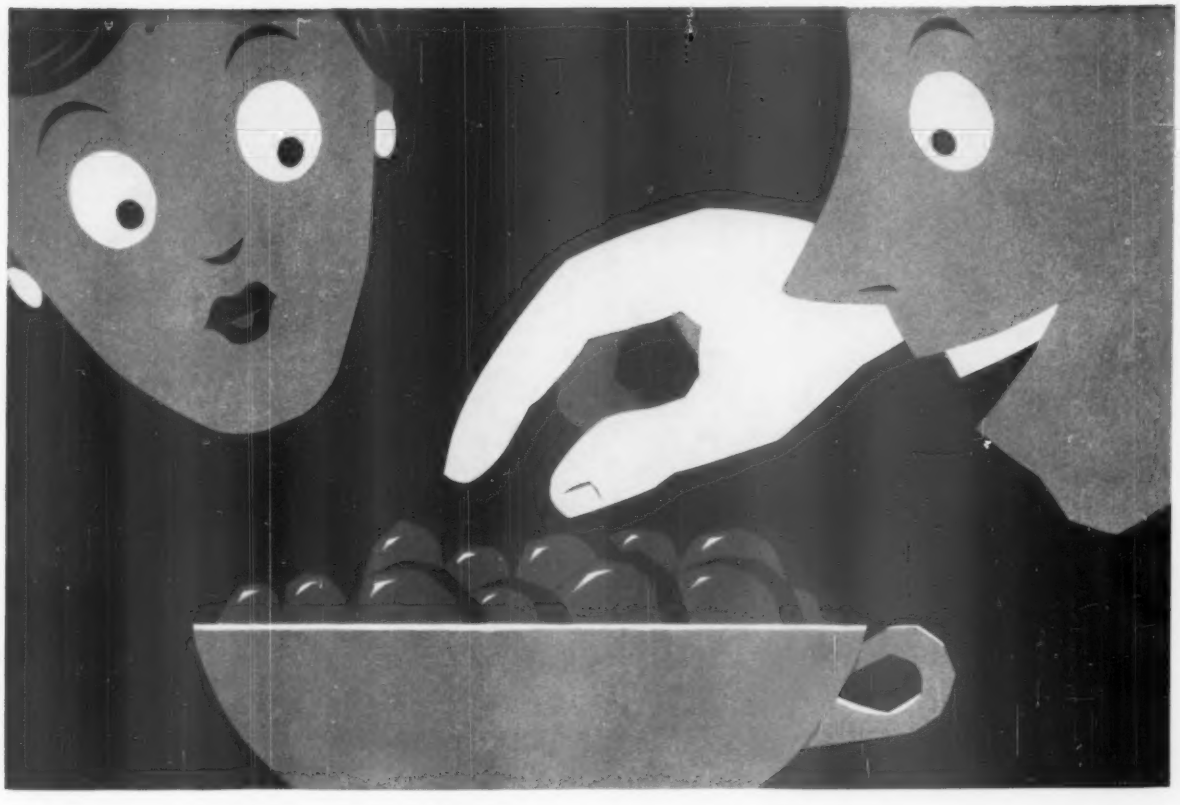
The procedure for this correction has been omitted here because a thorough presentation of this subject has been published by Davidson and Hanlon *(2)*. The authors have also prepared nomographs which reduce the mathematical burden to a simple measurement with a ruler.

LITERATURE CITED

1. Chichester, C. O. Comparison of color-measuring instruments. *Color in Foods. A symposium.* Quartermaster Food and Container Institute, Chicago (1954).
2. Davidson, Hugh R., and Hanlon, J. J. Use of charts for rapid calculation of color difference. *J. Opt. Soc. Am.*, **45**, 617 (1955).
3. Final report of the O.S.A. Subcommittee on the Spacing of Munsell colors. *J. Opt. Soc. Am.*, **33**, 385 (1943). These charts have been reproduced and are available in separate sets from Munsell Color Company, 10 East Franklin St., Baltimore, Md..
4. Final report on USDA contract No. A-IS-33008. Authorized by the Research and Marketing Act of 1946. Conducted by California State Agricultural Experiment Station, Department of Food Technology, University of California, Berkeley, California. July 1 (1954). See Appendix III by Paul Esau.
5. Judd, Dean B. *Color in Business, Science, and Industry.* 1952. John Wiley & Sons, Inc. New York, N. Y.
6. Nickerson, Dorothy. Color measurement and its application to the grading of agricultural products. *Misc. Publ. 588*, USDA (1946).
7. Nickerson, Dorothy. Interrelation of color specifications. U. S. Dept of Agriculture Production and Marketing Administration, Cotton Branch. (Paper given as part of symposium on color at a joint meeting of the Inter-Society Color Council and the Technical Assn. of the Pulp and Paper Industry held in New York, N. Y., February 25, 1947.)
8. U. S. Department of Commerce, National Bureau of Standards and U. S. Department of Agriculture Production and Marketing Administration, Cotton Branch (Personal communication).

August 31, 1957

Paul Esau
Department of Pomology
University of California
Davis



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Reactions of organic compounds. 3d ed. Wilfred John Hickinbottom. New York, Longmans, 1957. 619 p. $8.75. Revised and rewritten, with some new material.

Social and Economic Aspects

Case study of labor costs and efficiencies in warehousing formula feeds. William R. Askew and others. Washington, U. S. Govt. Print. Off., 1957. 27 p. (U. S. Department of Agriculture. Marketing research reports, 205.) pap. 20 c.

Costs of processing, warehousing and selling Florida citrus products, 1955-56 season. A. H. Spurlock and H. G. Hamilton. Gainesville, Fla., 1957. 14 p. (Florida Agricultural Experiment Station. Agricultural economics mimeo. report, 57-9.)

Materials handling in public refrigerated warehouses. T. H. Allegri and J. F. Herrick. Washington, 1957. 120 p. (U. S. Department of Agriculture. Marketing research report 145.)

A performance test of refrigerated rail cars transporting frozen foods. R. H. Hinds and others. Washington, 1957. 26 p. (U. S. Department of Agriculture. Marketing research report 182.)

Yearbook of food and agriculture statistics, 1956, v. 10, pt. 1., Production. New York, Columbia University Press, 1957. 468 p. (U.N., F.A.O. publications.) New features are official data for China, index numbers of agricultural production, and new material on prices.

Food Acceptance

Potato flakes—a new form of dehydrated mashed potatoes; market position and consumer acceptance in Binghampton, Endicott and Johnson City, New York. Washington, 1957. 54 p. (U. S. Department of Agriculture. Marketing research report 186.)

Purchasers opinion of frozen cranberries in Minneapolis-St. Paul. J. S. Hunter. Washington, 1957. 27 p. (U. S. Department of Agriculture. Marketing research report 183.)

Miscellaneous

Bibliographical forms for literature citations. James G. Hodgson. Chicago, Ill., Quartermaster Food and Container Institute for the Armed Forces, 1957. 62 p. "This manual presents a simple, unusual approach to some problems that tend to baffle the non-professional bibliographer and should be useful to researchers." *Library Journal.*

ABSTRACTS

—Compiled by H. A. Campbell

ANALYTICAL METHODS

A method of isolation of proteins from dilute solutions.

Webb, T., Sehon, A. H. and Rose, B. (McGill Univ., Montreal, Quebec). *Can. J. Biochem. & Physiol. 35,* 63-70 (1957).

The method consists of H_2O removal by prevaporation through standard Visking tubing combined with the simultaneous removal of salts and other low mol. wt. materials by dialysis. The maintenance of an optimal electrolyte content during the process of concn. is essential.

A rapid chromatographic assay of acetylsalicylic acid, acetophenetidin, and caffeine.

Levine, J. (Div. of Pharm. Chem., Washington, D. C.). *J. Am. Pharm. Assoc. 46,* 687-9 (1957).

A rapid procedure for the total analysis of acetylsalicylic acid, acetophenetidin and caffeine by a modified partition chromatographic technique is presented. Acetophenetidin and caffeine are sepd. in a manner similar to previous chromatographic sepns. Acetylsalicylic acid and any salicylic acid formed by hydrolysis are trapped on a segment of the column in which $NaHCO_3$ is the immobile phase; these acids are released and eluted by a chloroform soln. of acetic acid. The concns. of each substance are measured spectrophotometrically. The complete analysis may be carried out in 1 hr.

BIOLOGICAL SCIENCES

Biochemistry

The determination of serum albumin and globulin by a new method.

Debro, J. R., Tarver, H. and Korner, A. (Univ. of California School of Med., Berkeley). *J. Lab. Clin. Med. 50,* 728-32 (1957).

A new micro method is described for the detn. of serum albumin and globulin which depends on the soly. of the albumin in alc. trichloroacetic acid. The reagent renders the globulins insol. by denaturation. Total protein and albumin in soln. are detd. by the use of the colorimetric method of Lowry and coworkers.

Cholesterol and companions. X. The diol fraction.

Fieser, L. F., Huang, W. Y. and Bhattacharyya, B. K. (Chem. Lab., Harvard Univ., Cambridge). *J. Org. Chem. 22,* 1380-5 (1957).

A technique of inverse chromatography facilitated isolation from various cholesterol samples of 25-hydroxycholesterol, cerebrostendiol (24-OH isomer), 7-ketocholesterol, and an alkane-1,2-diol mixt. 25-Hydroxycholesterol appears not to be a product of animal origin but to result from air-oxidation of cryst. cholesterol.

The inositols.

Angyal, S. J. (New South Wales Univ. of Technol., Sydney). *Quarterly Rev. 11,* 212-26 (1957).

A review of the chemistry of inositol covering synthesis, structure, related compds., conformation and reactions.

The biosynthesis of sucrose.

Turner, J. F. (Botany School, Univ. of Cambridge, Engl.). *Biochem. J. 67,* 450-5 (1957).

An ext. from pea seeds which formed sucrose from glucose 1-phosphate and fructose was partially purified by pptn. with $(NH_4)_2SO_4$ and dialysis against phosphate buffer. The addn. of a boiled crude pea ext. was necessary to restore activity to the partially purified ext. The boiled crude pea ext. could be replaced by nucleotide fractions prepd. from peas or yeast. Magnesium ions were essential for the synthesis. The effects of concn. of Mg^{2+}, yeast-nucleotide fraction and substrates on sucrose synthesis were studied.

Reversible inactivation of lysozyme due to N, O-peptidyl shift.

Josefson, L. and Edman, P. (Dept. of Physiol. Chem., Univ. of Lund, Sweden). *Biochim. et Biophys. Acta 25,* 614-23 (1957).

It has been shown that lysozyme loses its enzymic activity when stored in anhyd. formic acid soln. at room temp., and that the activity is completely restored in aq. soln. at pH 7.5. The close dependence of the reversible inactivation on a likewise reversible N, O-acyl migration at the hydroxyamino acid residues of the enzyme protein has been demonstrated.

The significance of multiple reactions in enzyme-polymer systems.

Bailey, J. M. and French, D. (Dept. of Chem., Iowa State Coll., Ames). *J Biol. Chem. 226,* 1-14 (1957).

The endwise enzymic attack on a polymer is formulated kinetically in terms of k_1 (complex formation), k_{-1} (complex dissoen.), and k_2 (reaction to give products). The no. of times a substrate mol. is attacked during a single encounter is equal to k_2/k_{-1}. For enzymes which operate by multiple attack, the Michaelis const. is identical with k_{-1}/k_1.

Microbiology

The availability of lysine from Torula yeast.

Tsien, W. S., Johnson, E. L. and Liener, I. E. (Dept. of Agr. Biochem., Univ. of Minnesota, Minneapolis). *Arch. Biochem. Biophys. 71,* 414-22 (1957).

The availability of lysine from *Torula* yeast has been measured with chicks

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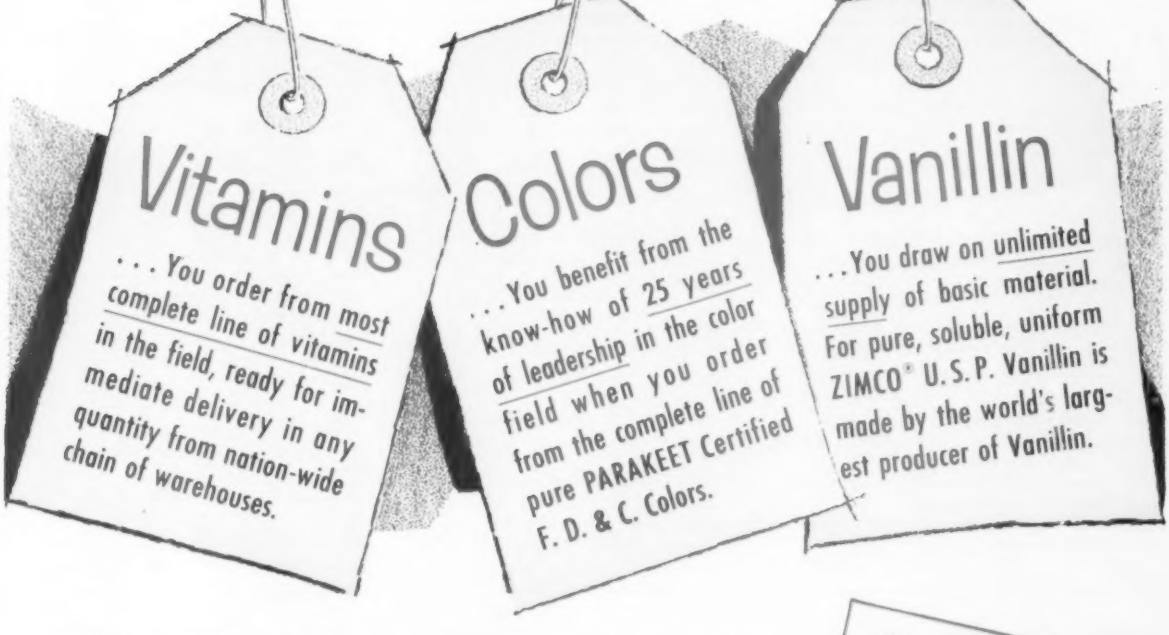
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and rats on the basis of growth response, feed or protein efficiency, N retention (chicks), and lysine absorption (rats). Consistently greater growth responses were obtained on lysine-deficient diets supplemented with 15-20% *Torula* yeast than could be accounted for on the basis of the lysine so provided. Measurements involving wt. gains, therefore, did not prove to be adequate criteria for evaluating lysine availability. On the other hand, N retention data disclosed that yeast lysine was about 75% as available to the chick as the synthetic substance. With rats, yeast lysine was about 90% as efficiently absorbed as the synthetic amino acid.

Quantitative estimation of chitin in fungi.

BLUMENTHAL, H. J. AND ROSEMAN, S. (Dept. of Bacteriol., Univ. of Michigan, Ann Arbor). *J. Bacteriol. 74*, 222-33 (1957).

The chitin content of 25 fungal strains were estd. quantitatively. When grown in shake flasks in an acid medium for 8 days, from 2.6 to 26.2% of the dry wt. of the fungal mycelium was chitin. Galactosamine could not be detected in the fungal chitin. Fungal spores contained chitin, whereas bacterial spores did not.

Antibiotics in poultry meat preservation: development of resistance among spoilage organisms.

NG, H., VAUGHN, R. H. AND STEWART, G. F. (Dept. of Food Technol., Univ. of California, Davis). *Appl. Microbiol. 5*, 331-3 (1957).

A study was made of organisms isolated from com. processed eviscerated chickens when deliberately spoiled at 7.2° C. (45° F.). The data collected clearly show that, where the chickens had been processed in the presence of chlortetracycline, resistant forms prevail. Such forms were not demonstrated on spoiling poultry which had been processed in plants not using chlortetracycline.

Combined irradiation-heat processing of canned foods. I. Cooked ground beef inoculated with Clostridium botulinum spores.

KEMPE, L. L., GRAIKOSKI, J. T. AND BONVENTRE, P. F. (Dept. of Bacteriol. and Chem. Eng., Univ. of Michigan, Ann Arbor). *Appl. Microbiol. 5*, 292-5 (1957).

Ground beef packed in tin cans and inoculated with *Clostridium botulinum* 213B spores was sterilized by combined irradiation-heat processing. Using 5,000-000 such spores/can, an F_0 of more than 0.6 was required to produce sterility following 1.0 megarep of γ radiation. Without irradiation F_0 values of approx. 1.0 were required. Combined irradiation-heat processing offers other advantages besides those related to the improved food quality and nutritive value that may result from the reduced quality of each of these forms of energy required when they are used together for food sterilization.

Food from fungi.

GILBERT, F. A. AND ROBINSON, R. F. (Battelle Memorial Inst., Columbus, Ohio). *Econ. Botany 11*, 126-45 (1957).

Fungi may some day be significant in furnishing human food through their protein-synthesizing capacity. The yeast, *Torulopsis*, has already been utilized on a com. scale in this direction in Germany, Jamaica, South Africa, California and Wisconsin. Data are presented on food values of mushrooms, and on the vitamin content and inorg. analysis of mushrooms and mushroom culture. Data are given on molds and products derived from molds. Yeast data are included. Sixty references.

Nutrition

Role of dietary fat in human nutrition. I. Role of unsaturated dietary fat in infant nutrition.

HANSEN, A. E. (Univ. of Texas School of Med., Galveston). *Am. J. Public Health 47*, 1367-70 (1957).

A review of recent work in the study of unsatd. acids in infant nutrition. Certain fatty acids, particularly linoleic acid are essential in infant nutrition and it is suggested that these nutritional constituents may play a more important part in adult nutrition than has hitherto been realized.

The influence of dietary fats on serum-lipide levels in man.

AHRENS, E. H., HIRSCH, J., INSULL, W., BLOMSTRAND, R., TSALTAS, T. T. AND PETERSON, M. L. (The Rockefeller Inst., New York). *J. Am. Oil Chemists' Soc. 34*, 563-70 (1957).

Feeding tests with dietary fats suggest that the major influence on serum-lipide levels is exerted by the glycerides, not the non-saponifiable fraction. The lowest serum-lipide levels were seen when corn oil, safflower-seed oil, or cottonseed oil constituted the sole dietary fats. Higher levels were found with all other fats tested. The differences in these levels are directly related to the degree of satn. of the glyceride fatty acids as measured by the iodine value of the fat. Use of hydrogenated corn and cottonseed oils as sole dietary fats resulted in higher serum-lipide levels than when the corresponding unhydrogenated oils were fed.

Nutritional quality of frying fats in commercial use.

MELNICK, D. (Best Foods Inc., Bayonne, N. J.). *J. Am. Oil Chemists' Soc. 34*, 578-82 (1957).

The author reports the results of a nation-wide survey of the frying oils in use on a continuing basis in the potato chip industry. Whereas a 1% decrease in iodine value has been found in the heated oils, this change has been shown to have no nutritional significance. The constancy in compn. of the frying oils, heated as compared to fresh, and the results of physico-chem. studies support the conclusion that neither thermal polymers nor thermal oxidative polymers are present in the oils employed in the com. frying operations. No *trans* fatty acids develop during the heating operations.

Nutritive value and safety of hydrogenated vegetable fats as evaluated by long-term feeding experiments with rats.

ALFIN-SLATER, R. B., WELLS, A. F., AFTERGOOD, L. AND DEUEL, H. J. (Dept. of Biochem. and Nutrition, Univ. of Southern California, Los Angeles). *J. Nutrition 63*, 241-61 (1957).

A multigeneration study in which rats have been fed a ration contg. 9.24% of a selectively hydrogenated vegetable oil as practically the sole source of fat in the diet has now been carried through 46 generations. The performances of rats of generations 26 through 46 as judged by gain in wt., tibia length, reproduction, lactation, longevity and carcass analyses have shown that the hydrogenated fats are of full nutritional value. It was concluded that selectively hydrogenated vegetable oils, such as are employed in margarine manuf., contg. positional and sfereoisomers of the unsatd. fatty acids, are fully digestible, harmless, and of full nutritional value as detd. by long-term studies conducted with rats. In all the multigeneration and longevity studies, herein reported, no deleterious effects were observed as a result of the ingestion of the small amts. of satd. fatty acids present in the hydrogenated fats.

Effect of different dietary fats on the faecal end-products of cholesterol metabolism.

GORDIN, H., LEWIS, B., EALES, L. AND BROCK, J. (Dept. of Med., Univ. of Capetown). *Nature 180*, 923-4 (1957).

A study of the quant. changes in the end products of cholesterol metabolism during the administration of different dietary fats. When hydrogenated coconut fat was fed alone, the serum cholesterol rose. When sunflower seed oil was fed before, in addn. to, or after the fat, there was a fall in the serum cholesterol level. Administration of either fat produced an increase in total fecal lipid. The fall in serum cholesterol level induced by sunflower seed oil has been assocd. with an increase in bile-acid excretion. These preliminary data are consistent with the tentative hypothesis that sunflower seed oil promotes the catabolism of cholesterol and its excretion from the body.

Prefeeding of high fat diet and resistance of rats to intense cold.

LEBLANC, J. (Army Chem. Med. Lab., Md.). *Can. J. of Biochem. & Physiol. 35*, 25-30 (1957).

It is shown that the larger amt. of fat

accumulated in the animals fed a high fat diet could not explain, either as a source of energy reserve, or as an insulator, the superiority of these high fat diets in maintaining the rectal temps. at higher levels in the cold. It is postulated that prefeeding a high fat diet, induces changes in the organism which sustain higher rates of heat production.

Amino acid imbalances in low protein diets.

DESHPANDE, P. D. (Univ. of Wisconsin). *Dissertation Abstr. 17*, 1889-9 (1957).

In an attempt to improve the low quality proteins of cereals by amino acid supplementation, imbalances of amino acids are produced. Ways and means of overcoming these imbalances were studied. It is suggested that the nutritional evaluation of proteins by their amino acid compn. is not sufficient. The actual availability of the amino acid is more important.

The net utilization of non-specific nitrogen sources for the synthesis of non-essential amino acids.

RECHCIGL, M., LOOSLI, J. K. AND WILLIAMS, H. H. (Dept. of Biochem. and Nutrition, Cornell Univ., Ithaca, N. Y.). *J. Nutrition 63*, 177-92 (1957).

The effectiveness of a mixt. of essential L-amino acids, single non-essential amino acids, diammonium citrate, urea and biuret as a source of N for the biosynthesis of non-essential amino acids was investigated. These nitrogenous compds. were added at isonitrogenous levels to a mixt. of essential amino acids, patterned after the compn. of the rat carcass. The amino acids were present exclusively in the L form. L-Glutamic acid and a mixt. of L-essential amino acids were the most effective supplements when judged by such criteria as growth response, food efficiency and net N utilization.

Effect of varying levels of DL-tryptophan in diet on dental caries in rats.

BUTTNER, W. AND MUHLER, J. C. (Indiana Univ., Bloomington). *Proc. Soc. Exptl. Biol. and Med. 95*, 309-11 (1957).

When either 0.6 or 1.8 g./kg. tryptophan was added to the diet there was an increase in dental caries, although the differences were not significant. When the diet contained 5.4 g./kg. tryptophan there was a significant increase in incidence of dental caries. Concomitant with the increased dietary tryptophan level, there was an increased salivary tryptophan concn.

Further studies on choline deficiency and muscular dystrophy in rabbits.

HOVE, E. L., COPELAND, D. H., HERNDON, J. F. AND SALMON, W. D. (Dept. Animal Husbandry and Nutrition, Alabama Polytechnic Inst., Auburn). *J. Nutrition 63*, 289-99 (1957).

Choline deficiency in rabbits fed the peanut meal-casein basal diet was char-

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acterized by poor growth, early death, fatty and cirrhotic liver, badly damaged heart muscle and valves, high creatine and low creatinine excretion, and hyaline degeneration of striated muscle. Betaine hydrochloride added to the diet at the 0.3% level markedly improved growth, prevented deaths and the muscle damage, but did not prevent heart and liver damage at the level fed. Choline chloride at 0.12% gave complete protection.

Antivitamins.

ZYMALKOWSKI, F. *Dtch. Apoth Ztg. 97*, 375-81 (1957).

A review of compds. having specific properties for decompg. or inhibiting the formation of a definite vitamin in the metabolic system; compds. other than those naturally present in the system are particularly considered. A study is made of the specific antivitamin behavior of antibiotics, and comparison is made between the structures of drug and vitamin. Naturally-occurring antivitamins discussed include those which actually destroy the vitamin (thiamine-splitting ferments present in raw fish and various ferns). The antivitamins present in many food and vitamin products (e.g. antivitamin E in cod-liver oil) are also studied.

Pharmacology and Toxicology

Absorption of drugs from the stomach. II. The human.

HOGBEN, C. A. M., SCHANKER, L. S., TOCCO, D. J. AND BRODIE, B. B. (Natl. Insts. of Health, Bethesda, Md.). *J. Pharmacol. Exptl. Therap. 120*, 540-5 (1957).

The human stomach is capable of absorbing most acidic drugs and the very weakly basic drugs. Salicylic acid, aspirin, thiopental, secobarbital and antipyrine, which are undissocd. in the acidic gastric contents, were readily absorbed. Phenol red, quinine, ephedrine and aminopyrine, which are almost completely ionized in acid soln., were not absorbed. These results are compatible with the hypothesis that drugs are absorbed by passive diffusion of their lipid sol. undissocd. form.

Aqueous oral preparations containing ascorbic acid, vitamin B_{12}, and ferrous gluconate.

GERBER, C. F., HETZEL, C. P., KLIOZE, O. AND LEYDEN, A. F. (Chas. Pfizer & Co. Inc., Brooklyn 7, N. Y.). *J. Am. Pharm. Assoc. 46*, 635-9 (1957).

Ascorbic acid, vitamin B_{12}, and ferrous gluconate, although mutually incompatible, may be compounded into stable, aq. oral prepns. by using com. 70% sorbitol soln. as a vehicle. Data are presented showing the stabilizing effects of sorbitol in two formulations contg. ascorbic acid, vitamin B_{12} and ferrous gluconate, and in a multivitamin formulation from which ferrous gluconate was excluded. Stability of these products is attributed specifically to their sorbitol vehicles.

Physiology

Tryptic digestion of native and chemically modified α-lactalbumin.

WEIL, L. AND TELKA, M. (Eastern Regional Research Lab., Philadelphia, Pa.). *Arch. Biochem. Biophys. 71*, 473-8 (1957).

The results obtained show that native α-lactalbumin was hydrolyzed to the extent of about 13 peptide bonds/mole of protein, in accordance with the sum of the arginine and lysine residues (1 + 12 moles). Acetylation or guanidination of the 12 ε-amino groups of the lysine residues resulted in a corresponding reduction in trypsin susceptibility, leading to the cleavage of only 1.5 peptide bonds/mole of protein. The authors conclude that peptide bonds adjacent to N-acetyllysine and homoarginine are resistant to the action of trypsin. The results also reaffirm the established specificity of trypsin.

ENGINEERING

Acidproof vessel construction with membrane and brick lining.

HONNAKER, L. R. (E. I. du Pont de Nemours & Co., Wilmington, Del.). *Corrosion 13*, 195t-204t (1957).

After a brief history of the development of brick-membrane vessel construction and the cements used, types of vessels and supporting structures are described. Design formulas are given. Recommended specifications and techniques are described. Membrane linings commonly used are listed and described, the technique of "holiday" testing is given, and cements are considered with respect to their suitability for various constructions and services. Data are also given on the various types of bricks, membranes, and cements.

FOOD AND FOOD TECHNOLOGY

Additives

Methemoglobinemia from eating meat with high nitrite content.

ORGERON, J. D. *Public Health Repts. 72*, 189-93 (1957).

Through epidemiological and lab. investigations 10 cases of methemoglobinemia were diagnosed as due to nitrite poisoning and resulted from eating wieners and bologna contg. large amts. of the chemical. The use of nitrites and nitrates in curing meats and the resulting bacterial and chem. reactions are discussed together with the Federal meat regulations. A reasonably complete epidemiology report covering the circumstances of the outbreak, condition of the cases, inspection and operation of the manufg. plant, along with lab. findings are given.

Cereals and Grains

The development of bitter principles in cereals.

ROTHE, M. *Ernahrungsforsch. 1*, 165-8 (1956).

A review of the nature and manner of development of bitter tastes in cereals, especially oats. The possibility of hydrolytic processes through the action of lipase and of oxidative processes by lipoxidases are proposed. Taste tests indicate that 2 bitter principles are involved.

Cocoa

Experiments on cocoa drying and fermentation in West Africa.

HOWAT, G. R., POWELL, B. D. AND WOOD, G. A. (Cadbury Brothers Ltd., Birmingham, Engl.). *Trop. Agr. (London) 34*, 249-59 (1957).

In some cocoa-growing areas it is desirable, and in others necessary, to dry the fermented cocoa beans artificially rather than by the heat of the sun. After a brief review of the different types of dryers in use and a statement of the problem of artificial drying, an account followed of exptl. work in Ghana with a dryer of the stationary tray type. It has been established that cocoa beans can be dried at high temp. and in a short time without detriment to the subsequent chocolate flavor.

Fats and Oils

Determination of tocopherol in oxidized fats.

FRANKEL, E. N., EVANS, C. D. AND COWAN, J. C. (Agr. Research Service, U.S.D.A., Peoria, Ill.). *J. Am. Oil Chemists' Soc. 34*, 544-6 (1957).

Heating oxidized fats to 210° C. under reduced pressure for 10 to 15 min. removed peroxides without affecting the tocopherol content. This simple heating method yielded a higher recovery of tocopherol in oxidized fats than other modifications of the Emmerie-Engel method used to remove interfering substances. The data indicate that tocopherol is not regenerated in the oxidized oils by the heat treatment. The loss of tocopherol in soybean oil which had been oxidized beyond the induction period was relatively small.

The sterols of coconut oil.

ANDERSEN, B. AND KRAWACK, B. (Aarhus Oliefabrik (A/S Arhus, Denmark). *Acta Chem. Scand. 11*, 997-1002 (1957).

Investigations on sterols produced from the distn. of coconut fatty acids ("pitchsterols") and from the extn. of crude coconut oil (crude oil sterols). Fractional crystn. from ethyl ether or propanol was used to sep. the sterol mixt. The consumption of Br according to Rosenmund-Kuhnhenn measured the sepn. α-spinasterol, stigmasterol, β-sito-

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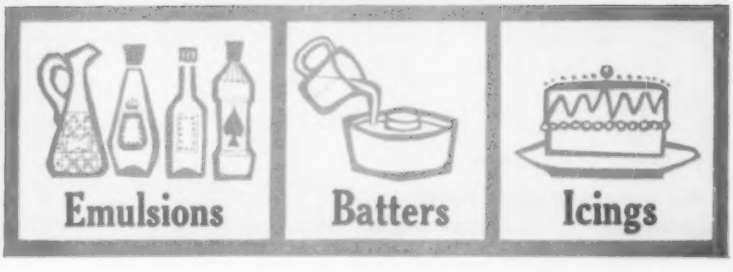

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sterol, and fucosterol were proved to be present in pitch sterols. Crude oil sterols contained in addn. to the 4 sterols found in the pitch, 1 sterol with conjugated double bonds in the 5,7-position and 1 sterol with a 7-double bond.

Foams

Inhibition of foaming. VIII. Changes in electrical conductivity of colloidal electrolyte solutions on addition of non-ionic foam stabilizers and foam inhibitors.

Ross, S. and Bramfitt, T. H. (Dept. of Chem., Rensselaer Polytechnic Inst., Troy, N.Y.). *J. Phys. Chem. 61*, 1261-5 (1957).

The effects of non-ionic foam stabilizers and foam inhibitors on the structure of the micelles produced spontaneously in solns. of colloidal electrolytes has been investigated by means of electrical conductivity measurements. At concns. above the c.m.c. foam stabilizers reduce specific conductance and foam inhibitors increase specific conductance; which facts are interpreted as resulting from increased micellization caused by foam stabilizers, and reduced micellization caused by foam inhibitors. The solubilization of foam inhibitors and the antifoaming action occur simultaneously, and both phenomena reach their optimum at the same concn. of additive.

A new theory of foam formation and its experimental verification.

Nakagaki, M. (Chem. Dept., Wayne State Univ., Detroit, Mich.). *J. Phys. Chem. 61*, 1266-70 (1957).

A thermodynamic theory of foam formation and of foam stability is developed using foam vol. and foam life as criteria. According to the theory, foaminess and foam stability in dil. solns. of relatively low viscosity increase with the energy required to transfer the excess solute from the surface into the body of the soln. The systems studied are aq. ale. solns., electrolyte solns., dyestuff solns. and gelatin solns. The theory is tested against exptl. data, part of which are taken from the literature.

Fruits and Vegetables

The relation of physical properties and chemical composition to mealiness in the potato. I. Physical properties.

Unrau, A. M. and Nylund, R. E. (Dept. of Biochem., Univ. of Minnesota, St. Paul). *Am. Potato J. 34*, 245-53 (1957).

A discussion of the phys. characteristics which appear to be assocd. with mealiness. Organoleptic tests conducted on 2 varieties of potatoes confirmed previous observations that potatoes within a variety which differ in sp. gr. differ in mealiness and potatoes of different sp. gr. may also differ in mealiness depending on the varieties being compared.

Eggs

Fatty acid composition of eggs as influenced by dietary fats.

Fisher, H. and Leveille, G. A. (Rutgers Univ., New Brunswick, N.J.). *Poultry Sci. 36*, 1116 (1957).

A practical means of incorporating large amts. of fats or oils (20-30%) into a poultry ration without making it unpalatable because of oiliness, has been achieved through the addn. of an absorbent to the diet. In this manner, the effect of tallow, corn, soybean, safflower, and linseed oil has been studied in terms of the linoleic and linolenic acid compn. of the egg fat. It was found that linseed oil produced a large increase in both the linoleic and linolenic acid content of egg fat, whereas soybean and safflower oil only increased the linoleic acid content, despite the fact that soybean oil contains 7-8% linolenic acid.

Meat and Poultry

Wet freeze-drying of muscle.

Meuller, H. and Szent-Gyorgyi, A. (Marine Biol. Lab., Woods Hole, Mass.). *Science 126*, 970-1 (1957).

Fresh frog Sartorius muscles were freeze-dried by immersing in acetone cooled by Dry Ice for one week and then extg. the H_2O and acetone. The result was a white prepn. that had the shape and appearance of the original muscle and was feather light. This method allows one to dehydrate muscle without destroying its mol. structure and contractility. The prepn. can be kept several weeks in the desiccator without loss of its contractility.

Effect of spices in feed on carcass flavor.

Newman, S. and Schaible, P. J. (Michigan State Univ., East Lansing). *Poultry Sci. 36*, 1145 (1957).

To det. if the feeding of spices could flavor the carcass of broilers, diets contg. dehydrated garlic, celery seed, allspice, sage, clove or monosodium glutamate were fed for 4 days to 9-week-old White Rock broilers. One lb. of flavoring agent was added to 5 lbs. of the basal ration. Only garlic was detected in the cooked carcasses; no identification of other flavors was made by the panel. Scores ranked high in acceptability for all birds, except those fed garlic. Flavoring agents reduced feed intake compared to the control ration.

The effect of various freezing methods on quality of poultry meat.

Marion, W. W. and Stadelman, W. J. (Purdue Univ., Lafayette, Ind.). *Poultry Sci. 36*, 1137-8 (1957).

Studies involving both 11 week old chicken fryers and mature Broad Breasted Bronze turkey males were conducted to det. the effects of 4 different methods of freezing on subsequent quality of cooked poultry meat. The freezing methods were as follows: 1) liquid freezer using a satd. NaCl soln. at 10° F. with

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brine flow adjusted to approx. 50 ft./min.; 2) liquid freezer, as above, for 15 mins. then transferred to a still air freezer at −10° F.; 3) still air freezer at −10° F.; 4) com. freezer at −20° F. with a mild air circulation (150 cubic ft./min.). Each group of poultry was packaged in polyvinylidine film, frozen by the above methods and stored at −10° F. for approx. 1 wk. prior to quality evaln. The results indicate that no statistically significant differences existed in the amt. of drip, cooking loss and tenderness of fryers frozen by the various methods. Also there were no statistically significant differences in the method of freezing on the quality of turkey meat.

Aureomycin as related to the microbiology and preservation of poultry meat.

SILVESTRINI, D. A., ANDERSON, G. W. AND SNYDER, E. S. (Ontario Agr. Coll., Ontario, Can.). *Poultry Sci. 36*, 1157 (1957).

Organoleptic and u.v. light examns. indicated that both the feeding of 1000 g./ton of aureomycin HCl or the addn. of 500 p.p.m. of the antibiotic to the drinking H_2O for a period of 1 day prior to slaughter delayed the onset of "off-odors" and production of slime in poultry meat stored at 40° F. The degradation of protein as detd. by the production of NH_3; the increase in bacterial population and the amt. of fluorescence on the samples under u.v. light are closely assocd. with the detection of spoilage by organoleptic examn.

PACKAGING

Polyethylene: preparation, structure, and properties.

AGGARWAL, S. L. AND SWEETING, O. J. (Olin Mathieson Chem. Corp., New Haven, Conn.). *Chem. Rev. 57*, 665-742 (1957).

A comprehensive discussion of the historical, phys., chem., structural, and optical aspects of polymerization and polyethylene. The processes used in the mfg. of polyethylene are reviewed. Five hundred and fifty references.

PHYSICAL RESEARCH

Anomalous viscosity behavior of polymer solutions at very low concentrations.

KAWAI, T. AND SAITO, K. (Tokyo Inst. of Technol., Tokyo). *J. Polymer Sci. 26*, 213-26 (1957).

A theoretical prediction has been obtained which indicates that an expansion of the polymer coils with diln. may play a significant role in the anomaly in the viscosity behavior of polymer solns. at very low concns. If the treatment developed here is of general validity, one would have to expect an analogous effect on various other properties of dil. polymer solns., such as d., light scattering, and osmotic pressure, insofar as these properties were measured accurately enough to verify the variation of mol. configurations with polymer concn.

RADIOCHEMICAL TECHNOLOGY

Degradation of biologically synthesized lactose labelled with Carbon-14.

CARLETON, F. J., ROBERTS, H. R. AND NUTTING, L. A. (Natl. Dairy Products Corp., Oakdale, N. Y.). *Nature 180*, 915 (1957).

An investigation on the distribution of C^{14} in both hexose moieties of lactose obtained from the milk of a goat employing $NaCHO_2$–C^{14} as the lactose precursor. The degree of labelling in each of the carbons of the isolated hexose moieties are in decreasing radioactivity: C nos. 4, 1, 6, 5, 3, 2.

Uptake of calcium-45 and strontium-90 from water by fresh-water fishes.

ROSENTHAL, H. L. (Dept. of Pathol., Rochester General Hosp., Rochester, N. Y.). *Science 126*, 699-700 (1957).

The uptake of Ca-45 and Sr-90 from the H_2O in which the fish swim was found to be linear with respect to time for the 3 species at all H_2O isotope activities studied. This may be interpreted to indicate the continual formation or exchange of the mineral component of bone, with sequestration of the isotopes into bone matrix. The apparent lack of discrimination of Sr-90 by fresh-water fishes probably reflects differences between fresh-water and marine fishes in absorption of the isotope by the gills, skin and intestinal tract rather than fundamental alteration in the metabolism of mineral elements of bone.

Vitamin content of foods exposed to ionizing radiations.

ZIPORIN, Z. Z., KRAYBILL, H. F. AND THACH, H. J. (U. S. Army Med. Nutrition Lab., Denver, Colo.). *J. Nutrition 63*, 201-9 (1957).

In 8 foods analyzed, namely, haddock, beef, turkey, ham (fresh), bacon, peaches, powdered milk and beets, turkey showed a significant decrease in riboflavin, while the niacin content was reduced in peaches. Thiamine was destroyed to the extent of 70 to 95% in all foods tested except powdered milk. The degradation of thiamine occurs by the splitting of the mol. into pyrimidine and thiazole moieties. The thiazole undergoes further degradative changes at higher doses of irradiation.

MISCELLANEOUS

Serotonin.

PAGE, I. H. (Cleveland Clinic Foundation). *Scientific American 197*, 52-6 (1957).

A review of the present knowledge of serotonin, a substance found in the blood, brain and in certain plants and fish. It is known to cause contractions of the arteries, intestines and bronchial muscles. It has a most significant effect upon the performance of the brain and may be a clue to the biochemistry of insanity. The chemistry and metabolism of serotonin are also discussed.

PRODUCTS

Two new types of "K" cellophane, one designed primarily for baked foods and the other for bag fabrication, were announced by the Du Pont Co. The new types represent further diversification of the company's line of "K" films.

The new 300 K-202 was developed primarily for use as a bag film and is said to offer machine performance and durability for items requiring long shelf-life and for products whose ingredients may affect the performance of conventional wrapping materials.

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A new lightweight **fluorocarbon tape** known as Fluorolin 101 has been developed by Joclin Mfg. Co. It consists of a base of three mils of DuPont Telflon coated one-side with three mils of special heat-stable, non-curing, pressure-sensitive adhesive with an operating temperature said to range from −100 to 500 degrees F.

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The company states that a special priming treatment gives high bondability to all materials, metal, glass, fabrics, plastics, painted and enameled surfaces. It is said to have a dielectric strength of 800 volts per mil and tensile strength of 1,000 lbs. per square inch. It features a slippery-smooth, antifriction surface which is claimed to make it an ideal releasing agent for use by food and drug conveyors, bread-wrapping machines, and for facing the heat-sealing bars on polyethylene bag and pouch-making machines. A 10-mil variety is available.

A **metallized paper,** said to be useful for can and bottle labels or as carton overwraps and tight wraps for set-up boxes, has been developed by the Shellmar-Betner Flexible Packaging division of Continental Can Co.

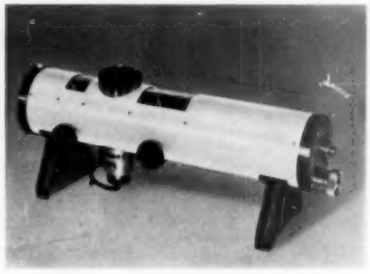
According to the company, test indications show that the paper, which is said to be much like aluminum foil laminations in appearance, will be low in cost. One feature the company highlighted was the paper's lending itself well to printing. It is now available in limited amounts commercially while additional production facilities are installed.

EQUIPMENT

The FMC Shaker-Type **Nubbin Separator** is now being introduced to the industry by the Canning Machinery division of Food Machinery and Chemical Corp. The machine is designed to remove all of the nubbins in green and wax bean operations, and it also separates the specified cuts from the shorter cuts.

According to the company the machine employs the principle of oscillation, the frequency of which is controlled by a variable speed pulley drive. The cut beans move in a horizontal position over perforated screens without up-ending. It can also be adapted for use as a scalper of pea feeding lines for removing pods, stems and chaff.

The new Weka **Photo Electric Colorimeter** is designed for analysis of metals in steel and iron alloys as well as in other metal alloys and for general technical and bio-chemical analysis of various kinds.



It features a graduated drum with 1,000 divisions which the distributor, Epic, Inc., states will give accurate readings from 0.1 to 0.2%. The instrument uses two barrier-layer photocells in a balanced circuit.

According to the company, the sensitivity characteristics of the photocells have no influence on the measuring results. Measurements are independent of fluctuations of light intensity, and measurements can be done in full daylight. Several types of lamps are available for either polychromatic or monochromatic light as well as for fluorescence measurements. The sole U.S. distributor is Epic, Inc., 154 Nassau St., New York 38, N.Y.

The "Chromomax" analyzer is a new **gas chromatography instrument** which is said to be able to analyze as many as four process streams containing natural gases, vapors, low boiling point liquids and hydrocarbons, with eight such components in each stream.

The "Chromomax", developed by Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa., is also said to have an explosion-proof analyzer unit, a programming unit and a "Speedomax" G recorder. It provides temperature control of the unit itself, an air circulation system without blower motors, and detectors consisting of special low volume cells with hot wire filaments.

The programming unit provides controls to perform an analysis, continuous peak attenuation of each component, and activation of the recorder chart advance. The recorder draws either a bar record or a spectrum of an analysis.

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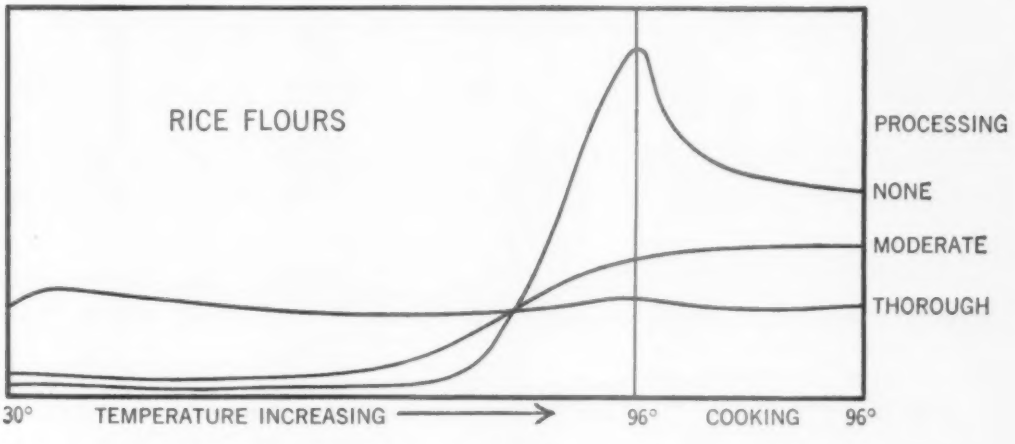

EXAMPLE: The above amylograms illustrate the effect of varying degrees of thermal treatment upon the cooking characteristics of rice flour. Raw rice flour thickens rapidly but is followed by appreciable "Set-back" upon extended cooking. Thoroughly processed rice flour hydrates well in cold water and maintains its viscosity throughout the heating and cooking cycle. Quaker can supply rice flours with any degree of processing within these limits.

Now Quaker can supply you with flours pregelatinized to fit your processing needs.

Quaker's control over gelatinization combined with special grinding and drying techniques can provide corn, barley, rice and wheat flours which thicken rapidly upon heating or which exhibit very little viscosity change during heating.

Pregelatinized, low bacteria flours or meals may shorten the processing time required to produce commercially sterile canned goods. They may also reduce the time needed for cooking, gelatinizing, or dextrinizing.

Quaker will help you select the type of flour and the degree of gelatinization best suited to your products. For information on this service, write to address at right.

QUAKER

Industrial Food Sales Department
The Quaker Oats Company
Chicago 54, Illinois

A vibrator for cleaning filters has been announced by Hercules Filter Corp., 175 Ethyl Ave., Hawthorne, N. J. This device, it is said, can be installed on filters with capacities from 100 to 1000 square feet.

Tests conducted have revealed cake on filter leaves can be vibrated off in a matter of seconds, the firm reported.

MEMORANDA

Technical advances in the milling and baking industries were described by C. L. Brooke, an IFT member and president-elect of the American Association of Cereal Chemists, in a recent talk before the pilot session on new instrumentation for in-stream food analysis held at Rutgers University.

Mr. Brooke, who is associated with Merck & Co., Inc., pointed out, however, that further progress must be made, and urged increased use of newly developed scientific techniques.

He suggested that ultra-sonics might be applied to facilitate the conditioning of wheat, and expressed the hope that instruments might be developed for recording moisture and its distribution in the wheat kernel, as well as for determining the "millability" of conditioned wheat.

He cited the need of millers for feeders which are more accurate and durable than those currently in use, and particularly for a type that would be reliable in proportioning small quantities of improvers and micronutrients into flour.

Mr. Brooke also dwelt at some length on the possibility of developing in-stream measuring methods in the production of flour, prepared mixes, breakfast cereals and baked foods.

The architect's sketch of a new food science building and pilot plant to be erected on the grounds of Cornell's New York State Agricultural Experiment Station at Geneva, a unit of the State University. Bids on the building were opened in Albany January 23 and work is expected to get under way early this spring. Of brick and limestone construction, the building will have a frontage of 252 feet with two stories above ground in the front and three stories in the rear. A two-story pilot plant will be 60 by 107 feet and will be attached to the main building by an "isthmus" 40 by 65 feet. The structure will include many unique features, including 24 modern chemical and bacteriological laboratories with moveable partitions for enlarging or reducing laboratory space as required. There will also be special storage rooms for processed foods with controls for a wide range of temperature and atmospheric conditions. An underground irradiation room will make possible research on the use of atomic energy for food processing. It will also be possible to irradiate plant material in genetic studies in connection with the extensive fruit and vegetable breeding work carried on at the Experiment Station. A modern test kitchen and taste panel room and a large machine shop will also be provided. The building will be by far the largest structure on the Station grounds and will house the work on bacteriology, chemistry, and food processing.

IN MEMORIAM

Harry Willard von Loesecke, veteran research scientist of the U. S. Department of Agriculture and one of the country's outstanding food technologists, died January 19 in Washington, D. C., after an illness of several months. Widely known for his contributions to improved processing of citrus fruits and to research on dehydration of fruits and vegetables, Mr. von Loesecke was serving at the time of his death as a member of the Internal Audit Staff of USDA's Agricultural Research Service. He had completed 27 years of Government service.

Mr. von Loesecke was a native of Lynn, Mass. He received his B.S. degree from Harvard University in 1922 and began his career as a research chemist with the General Electric Company and the American Protein Corporation before joining the staff of the United Fruit Company in Boston, Mass., in 1927. During his four years with this company, he was concerned primarily with research on the chemistry of bananas and with production techniques for obtaining cellulose from the stalk residue of sugar cane. In 1931, Mr. von Loesecke was appointed chemist in charge of USDA's Citrus Products Laboratory at Winter Haven, Fla. Work done there under his direction contributed to important improvements in pasteurization and other aspects of the processing of citrus fruits and juices. He was detailed in 1941 to the USDA Western Utilization Research Laboratory at Albany, Calif., as a member of the Laboratory's 3-man committee in charge of food-dehydration research, undertaken to develop dried foods needed by U. S. and allied armed forces during World War II.

From 1934 to 1947, Mr. von Loesecke served in Washington, D. C., with the War Food Administration and later with USDA's Production and Marketing Administration as an industrial specialist in food technology. He then joined the Department's Bureau

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of Agricultural and Industrial Chemistry as technical assistant to the Bureau chief. In 1955 Mr. von Loesecke joined the Internal Audit Staff of the Agricultural Research Service, where he aided in coordinating USDA research efforts in food processing and related fields.

A resident of Silver Spring, Md., Mr. von Loesecke was author of 3 books and some 40 technical papers dealing with food technology and biochemistry.

PERSONNEL

John H. Nair, a Founder Professional Member of IFT and presently a member of the Executive Committee, has retired from Thomas J. Lipton, Inc. after rounding out over four decades of experience in the food industry. He has announced the opening of a consulting practice with offices in Summit, New Jersey. His attention will be devoted to advising food companies on new products, processing problems, consumer testing, flavor acceptance and research administration. Mr. Nair spent nearly a quarter of a century with the Borden Company in Technical Sales, Quality Control, Chemical Research and Research Administration. Early in World War II he joined Thomas J. Lipton, Inc. where he has served as Assistant Director of Research and Advisor to the Technical Department of Unilever, Ltd. Mr. Nair has taken an extremely active part in the affairs of the Institute, as well as those of the American Chemical Society and the American Institute of Chemists, of which he is a past president, and the Association of Research Directors, of which he is the immediate past president.

F. Leslie Hart, formerly chief of the U.S. Food and Drug Administration's Boston District, has been appointed by Truesdail Laboratories as Director of Food and Drug Technology. He will head the Los Angeles scientific research organization's activities in the field of food labelling, new drug permits and other matters involving federal and state regulations.

Dr. Stephen S. Chang, a member of IFT, has joined the A.E. Staley Manufacturing Co. as a senior research chemist in edible oils. Dr. Chang, who was born in North China, received his B.S. degree in chemistry at Chi-Nan University in Shanghai in 1941. In the U.S. he studied at the University of Wisconsin, completed work on his Master's degree in chemistry at Kansas State College in 1949, and received his Ph.D. in food chemistry in 1952 at the University of Illinois, where he contined in research work with some teaching duties in food technology until 1955. He has been doing research with edible oils and fats for Swift & Co. since that time.

Walter K. Scharmack has recently been appointed director of technical development for The Diversey Corp. He will be in charge of new product development and field evaluation of industrial chemicals for this company, according to Lewis Shere, president of The Diversey Corp.

Dr. Lyle L. Davis, a member of IFT, has been appointed food technologist for Stone Container Corp., Eastern division, Philadelphia. In this newly created position, Dr. Davis will advise on the proper quality of food product and proper design of packaging for newly designed corrugated shipping containers.

His services will be availabe for food processors in an area including Pennsylvania, New Jersey, New York, Delaware, Maryland, Virginia and the District of Columbia.

Dr. Davis has been food technologist for the U.S. Department of Agriculture for the past four years. Previously he was professor of horticulture at Virginia Polytechnic Institute, University of Tennessee and South Dakota State College.

Dr. Wendell A. Landmann has joined the staff of the American Meat Institute Foundation at the University of Chicago as chief of the division of analytical and physical chemistry. He assumes responsibilities previously administered by **Dr. D. M. Doty,** who now relinquishes supervision of activities of this division to devote attention to his responsibilities as associate director of research and education.

Dr. Jack M. Sheneman has recently joined the Research Department of Wisconsin Malting Company as Research Associate. He was educated at the University of Michigan and at Michigan State University where he received his doctorate in Microbiology. He held the position of research assistant for three years in the food bacteriology section at Michigan State University. His research experience has included work in the microbiology of foods and fermentations, food preservation, and in biological chemistry.

Bruce L. Durling has been named president of the Wm. J.

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Stange Co. by the board of directors of that firm. He succeeds his father, **W. B. Durling,** who was elected chairman of the board.

Also elected were **T. R. Miles,** executive vice president, and **Earl M. Johnson,** assistant secretary-treasurer.

Mr. Durling has been associated with the company since 1942, and has served as vice president since 1951. He has been director of the technical and research departments since 1954.

Louis Mignacca was recently named as special representative in the New York office of Fries & Fries. Mr. Mignacca was formerly associated with the Pearson Pharmacal Co. and Dodge & Olcott, Inc. He holds a bachelor of arts degree from Brown University and has completed a special training course at Fries & Fries which prepared him for technical sales and service.

Dr. Donald K. Tressler has resigned his position as Scientific Director of the Quartermaster Food and Container Institute for the Armed Forces, Chicago, Illinois. He is returning to his consulting practice as Manager of Donald K. Tressler and Associates, with Laboratories on North Compo Road, Westport, Conn. He will also be Editor of the Avi Publishing Company, publishers of food technology books, also located in Westport.

John E. Slaughter, Jr. has been appointed president of the new Girdler Process Equipment division of National Cylinder Gas Co., with **Lyman L. Dawson** as vice president.

Activities of the new Girdler Process Equipment division include production of Votator and Thermex equipment.

Three other new divisions were also announced by the company as part of a major change in the organizational structure. The Girdler division will supply automatic continuous processing equipment to the food, plastics, chemical, rubber, textile and other industries it was announced.

Keith A. Fitch, an IFT member, has recently been named as branch manager of the Selig Co.'s Kansas City operation. Mr. Fitch was formerly executive director of the Orkin Institute of Industrial Sanitation, and has held posts with Standard Brands, the California Department of Public Health, and the U.S. Food and Drug Administration. He has served as a consultant to leading food manufacturers. Mr. Fitch is a colonel in the USAF Reserve. He is a Registered Professional Engineer and Registered Sanitarian; a fellow of the American Public Health Association; a member of the American Association for the Advancement of Science, National Society of Professional Engineers, International Association of Milk and Food Sanitarians, and Association of Food and Drug Officials of the U.S.

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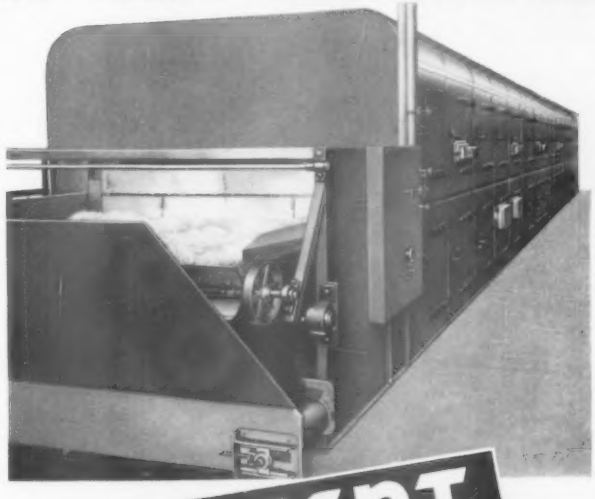

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From the Sargent-designed slurry tank, pre-cooked rice feeds into the wet section of the dryer at approximately 70% moisture content. In this first 8-fan zone, the air circulates up through the bed of travelling rice, carrying moisture out through strategically placed exhaust ducts. The following 8-section zone reverses the air flow *down* through the drying rice, and the third, 4-section zone directs cooler, dry air *up* again. This Sargent-designed process is job proven as the most economical, speedy and efficient method for drying rice and assures quality protection. Rice leaves the dryer at 8% moisture content.

Total exposure time: 9 minutes. Capacity: 2,000 lbs. hourly.

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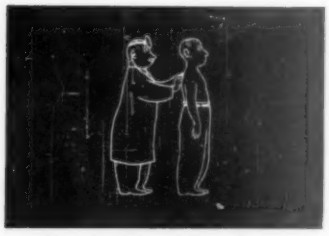

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